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EAST AFRICA HIGH COMMISSION

EAST AFRICAN AGRICULTURE AND FORESTRY RESEARCH ORGANISATION

(Incorporating the East African Agricultural Research Institute, Amani)

ANNUAL REPORT 1950

Postal Address: P.O. Box 21, Kikuyu, Kenya

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PRINTED BY ZENITH PRINTING WORKS LTD., NAIROBI

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Staff List as at 31st December, 1950

(Including Officers of the Fertiliser Scheme and the Clove Research Scheme, Zanzibar)

DIRECTOR

B. A. Keen, D.Sc., F. Inst. P., F.R.S.
(On Vacation Leave March—September 1950)

DEPUTY DIRECTOR

H. H. Storey, C.M.G., M.A., Ph.D., F.R.S.

RESEARCH OFFICERS

H. F. Birch, Ph.D., F.C.S. — *Soil Chemistry.*

I. W. M. A. Black, Ph.D., A.I.C.T.A. — *Soil Chemistry.*
(Vacation Leave pending retirement May-December 1950).

G. T. Chamberlain — *Spectrography.*
(Assumed duty November 1950)

L. R. Doughty, B.Sc. (Agric.) N.D.A. — *i/c Fertiliser Scheme.*
(Returned from Vacation Leave

D. W. Duthie, M.A., Ph.D., F.R.I.C. — *Asst. to Director. Editor, E.A. Agric. Jnl.*

G. H. Gethin Jones, M.Sc. — *Soil Survey.*
(Assumed duty December 1950)

J. Glover, M.Sc. — *Plant Physiology*
(Returned from Vacation Leave April 1950).

P. J. Greenway, O.B.E., F.L.S. — *Systematic Botany.*

P. R. Hesse, B.Sc., A.R.I.C. — *Soil Chemistry.*
(Assumed duty February 1950)

D. L. Jennings, B.Sc. — *Plant Breeding.*
(Assumed duty November 1950)

K. S. McKinlay, B.Sc. — *Entomology*
(Assumed duty November 1950)

A. L. Griffith, O.B.E., M.A., D.Sc. — *Forestry*
(Assumed duty February 1950)

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I. W. M. A. Black, Ph.D., A.I.C.T.A. *(Vacation Leave pending retirement May-December* 1950).	*Soil Chemistry.*
G. T. Chamberlain *(Assumed duty November* 1950)	*Spectrography.*
L. R. Doughty, B.Sc. (Agric.) N.D.A. *(Returned from Vacation Leave*	*i/c Fertiliser Scheme.*
D. W. Duthie, M.A., Ph.D., F.R.I.C.	*Asst. to Director.* *Editor, E.A. Agric. Jnl.*
G. H. Gethin Jones, M.Sc. *(Assumed duty December* 1950)	*Soil Survey.*
J. Glover, M.Sc. *(Returned from Vacation Leave April* 1950).	*Plant Physiology*
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D. L. Jennings, B.Sc. *(Assumed duty November* 1950)	*Plant Breeding.*
K. S. McKinlay, B.Sc. *(Assumed duty November* 1950)	*Entomology*

R. F. W. Nichols (*On Vacation Leave March-August* 1950).	*Plant Pathology.*
F. J. Nutman, D.Sc., D.I.C. (*Seconded as Director Clove Research Scheme*).	*Plant Physiology.*
P. Robinson, B.A., Dip. Stat.	*Statistics.*
D. Rudd Jones, M.A., Ph.D.	*Plant Pathology.*
Miss F. M. L. Sheffield, D.Sc. (*Seconded to Clove Research Scheme*).	*Cytology.*
B. Verdcourt, B.Sc.	*Systematic Botany.*

SCIENTIFIC ASSISTANTS

Miss A. L. Alexander, B.Sc. (*On Vacation Leave March-August* 1950).	*General Analysis.*
Miss D. M. Cooper, Dip. Agr.	*General Analysis.*
W. B. May, F.R.H.S. (*Seconded to Clove Research Scheme September* 1948)	*Horticulture.*
Mrs. A. K. Ryland, B.Sc.	*Plant Pathology.*
Miss E. Smith, B.Sc.	*Spectrography.*
Count A. E. Staryenski (*Assumed duty July* 1950 *on transfer from expired C.D. & W. Scheme* 255).	*Systematic Botany.*

FIELD AND FARM STAFF

D. W. Gourlay, B.A. (Agric.)	*Field Experimentalist.*
H. P. Ledger, N.D.D. (*On Vacation Leave May-December* 1950).	*Farm Manager.*
W. J. L. Arthur-Worsop (*On Vacation Leave pending Retirement August* 1950).	*Field Assistant.*

T. Brodie (*Resigned November* 1950).	*Field Assistant.*
T. Graham (*On Vacation Leave June-December* 1950).	*Field Assistant.*
P. H. Hosegood	*Field Assistant.*
J. D. Roberts	*Asst. Superintendent of Plantations.*
T. E. C. Robins (*Assumed duty with Fertiliser Team November* 1950).	*Field Assistant.*

ADMINISTRATIVE STAFF

T. Matthews, T.D.	*Secretary.*
S. G. Walter (*On Vacation Leave November* 1950).	*Asst. Accountant.*
D. Smith	*Storekeeper*
Miss M. A. E. Vardy	*Private Secretary to Director.*
T. V. Greenwood	*Engineer.*
L. C. Martin, M.B.E. (*Seconded to E.A. Railways and Harbours*).	*Clerk of Works, Muguga.*
Miss J. Ossent, M.A.	*Research Librarian.*

TEMPORARY CLERICAL ASSISTANTS

Mrs. P. C. Martin
(*Assumed duty September* 1950).

Mrs. F. K. O'Hagan
(*Assumed duty September* 1950).

Miss J. Nutman
(*Assumed duty December* 1950—*seconded from Clove Research Scheme*).

Mrs. D. M. Smith

Mrs. M. Y. Robinson
(*Resigned August* 1950).

UNDER COLONIAL DEVELOPMENT & WELFARE SCHEMES ADMINISTERED BY THE ORGANISATION

A. Walter, O.B.E.	*Agricultural Meteorology.*
W. V. Harris, M.Sc.	*Termite Research.*
Miss P. B. Kemp, B.Sc.	*Termite Research.*
C. G. Trapnell, O.B.E., B.A.	*Ecological Training.*

(*Assumed duty November* 1950
on secondment from
N. Rhodesia).

REPORT BY THE DIRECTOR

Introduction

The Annual Report of a research organisation should, normally, include only brief references to buildings, to administrative and staff matters, and usually then only for purposes of formal record. But it has been necessary, in the present Report, as in the previous two, to deal with these matters in some detail. The progress of the building scheme, involving a large capital contribution of £295,000 from the home government under the Colonial Development and Welfare Acts, must obviously be reported in some detail. Again, the conception of a regional Research Organisation is a novel one in British Colonial history, and its successful functioning will be largely—but not, of course, exclusively—dependent upon the creation of flexible and easy contacts between the Organisation and the territorial bodies and individuals concerned; here, problems of facilitating joint or team researches arise, together with the complementary problem of keeping the necessary administrative and financial procedures on a level where they serve rather than obstruct the scientific objects. Clearly some account of the progress made in these problems is needed, both in its own right, and as guidance for those concerned in similar developments elsewhere. Finally, some account of staff matters is necessary because many cuts have been made in both the material facilities contemplated in the original scheme, and in the size of the scientific staff needed to carry out the work.

It is only because matters such as the above have bulked largely in the 1950 activities of the Organisation, that they are placed in the present Report ahead of the discussion of the year's research. Research is, and will remain, the primary concern of the Organisation.

Construction of Headquarters

As mentioned in the 1949 Report, the main building programme at Muguga began in November 1949. Considering the difficulties in planning due to delay in arrival of essential materials, the revision of designs, and changes during the actual construction to make yet further economies to meet ever-rising prices, the progress has been highly satisfactory. This has been largely due to the efforts of Dr. Duthie, who has had charge of the technical planning of the laboratories and headquarters—in addition to editing the East African Agricultural Journal (see p. 17), and to Mr. Martin, Clerk of the Works, who has dealt efficiently with every situation that arose.

The Workshop (3,600 sq. ft.), the Central Store (2,000 sq. ft.) and the Gas Producer House (1,000 sq. ft.) have been completed, but delay in the arrival of the gas plant and of the main wiring of the electric supply has postponed the completion of fittings. Three laboratory blocks, with a total floor space of 13,000 sq. ft., have been completed and are now being fitted with benches, gas, water and electricity services. The Library (6,600 sq. ft.) is nearly finished and the steel shelving for it is expected within a few weeks. The Administration block (11,500 sq. ft.) is within sight of completion and will house the offices of E.A.A.F.R.O., E.A.V.R.O., the Inter-

national Bureau of Epizootic Diseases, and the offices of the Animal Husbandry Division, which is controlled jointly by the Directors of E.A.A.F.R.O. and E.A.V.R.O.

Fifteen medium and five small European houses have been completed, and three additional houses have been built for a Leather Chemist, the officer in charge of the Training Scheme for Ecologists, and for the Director of the Bureau of Epizootic Diseases. Funds for these three houses were provided from other sources. Three senior European houses are now being built for the Directors of E.A.A.F.R.O. and E.A.V.R.O. and for the Deputy Director of E.A.A.F.R.O. Construction of the hostel will begin shortly; it will house members of E.A.A.F.R.O., E.A.V.R.O., Bureau of Epizootic Diseases, and Ecology Training Scheme. Funds for its construction have been obtained from all these schemes and it is probable that additional rooms will be built for the Colonial Termite Research Scheme. Forty-four junior African quarters, two senior African quarters and four Asian quarters have also been completed.

Work is proceeding on laboratories for the Ecology Training Scheme, which are being erected to conform with the overall site plan for Phase II of the building programme. Funds for the construction of these laboratories are provided under the C.D.and W. grant for that scheme.

After unavoidable delays it was possible to draw up building plans for the Animal Husbandry Division. It is hoped to begin construction early in 1951. Meanwhile, with the return of Mr. Ledger, Farm Manager, from his tour of East African animal husbandry centres, and from vacation leave, development of the area—fencing, clearing, lay-out of paddocks, etc.—has begun.

Machinery for Organising Research

In pursuance of the policy set out in the first (1948) Annual Report, in which three stages between research and introduction to practice are recognised, the Organisation has kept the "specialist committee" type of procedure in mind. Reports of the committees on Water Utilisation by Vegetation, Grassland Research, and Fertilisers were circulated to all members of the East African Advisory Council on Agriculture, Animal Health and Forestry, and the major parts of the reports were also given wide circulation in the East African Agricultural Journal.

The committee of the Conservators of Forests, with the Director, E.A.A.F.R.O. as Chairman, appointed by the Advisory Council at its first meeting, was enlarged to include specialist officers. Dr. Griffith, after his tour of East African territories and consultations with Conservators, drew up an extensive study-group programme for this committee. Full agreement was reached regarding the choice and direction of researches in silviculture, pathology and entomology (see Report of Forestry Section pp. 29-30). The need for a specialist committee on insecticides and entomology, in view of the somewhat disconnected activities in these fields, was made evident when the one junior entomologist recently appointed to the staff was, by arrangement, posted to Uganda to form the E.A.A.F.R.O. member

of a team including entomologists from the Empire Cotton Growing Corporation and the Uganda Department of Agriculture. This committee will keep the various East African entomological and insecticide researches under view and suggest useful co-ordinations and extensions. It will not deal with locusts, tsetse flies, quarantine, or virus research.

The Directors of the Agriculture and Veterinary Departments, with the Directors of E.A.A.F.R.O. and E.A.V.R.O., met as a special committee to consider the limited building and research programmes for the joint Animal Husbandry Division, which will begin research in 1951. They recommended that, when the Division is created, its head should become chairman of a specialist committee that is to review central and territorial research programmes, to prepare and supervise further programmes and to collate and co-ordinate the results. (*Note*: At its meeting in January 1951, the Advisory Council supported the formation of the above two specialist committees.)

Co-ordination of other research work, provided for by Director or Deputy Director membership of other research committees—e.g. Overseas Food Corporation—has worked well. During 1950 the Scientific Council for Africa South of the Sahara, agreed to by the metropolitan powers and the Union of South Africa, was set up. The Director was appointed a member of the Council, to represent agricultural research and East Africa, and Dr. Storey was appointed Alternate Member. Dr. Storey was also a member of the Kongwa Working Party that made recommendations on the future agricultural programme of that area. The Director and Dr. Duthie were present at the Hydrological Conference held in Nairobi in November.

The re-orientation of the Kenya fertiliser scheme towards grassland fertiliser problems (see p. 10) does not mean any loosening of the past co-operation, because Mr. Doughty has been co-opted on to the small Kenya Department of Agriculture Committee concerned.

In the more purely administrative aspects, however, the year 1950 has seen some important changes which, it is hoped, will check what threatened to be a very cumbrous procedure. The Standing Research Committee of the Advisory Council found itself, at the two meetings it held in that year, in an anomalous and difficult position. Although it was only a committee of an advisory body, its agenda—American aid under Economic Co-operation Administration (Report, 1949, p. 6) and the staff and financial implications thereof—necessarily involved taking decisions of an executive nature, whereas its own parent body possessed only advisory functions. This situation showed the need for setting up at an early date something in the nature of a Governing Body or Board, which is the universal method of operating research institutes. For administrative and financial reasons in the High Commission constitution, it is not yet possible to create such a body for the Research Organisations. But a Research Organisations Committee with a smaller but similar membership to the Standing Research Committee, and divorced completely from the Advisory Council, should provide a temporary solution. (*Note*: At the January 1951,

meeting the Advisory Council recommended that this proposal be adopted).

Advisory visits, or postings, of E.A.A.F.R.O. staff to territories, and advisory visits of territorial specialists to E.A.A.F.R.O. activities have taken place under a simple administrative procedure. The financial and accountancy procedures of Colonial Regulations, however, continue to present difficulties especially when joint work with other bodies, and team work, is contemplated. As team work is usually the best means of obtaining the maximum value from public money allocated to research, there are good reasons why procedures that prevent this should be modified.

Staff

The reduced capital development scheme could provide laboratory and housing accommodation for less than one-half of the Establishment that was envisaged as the minimum necessary for an efficient regional research organisation. This Establishment of 45 research officers was to be reached over the period of 10 years ending in 1957. The C.D. and W. scheme made for this purpose took, to begin with, the first five years and provided for 35 research officers (plus scientific and technical assistants and administrative staff) at the end of 1952. The Standing Research Committee recommended at the meetings mentioned in the preceeding section, and the High Commission Central Assembly subsequently decided, that as for 1951 (and, by implication, for 1952), the running costs of the Organisation would exceed the funds still available in the C.D. and W. scheme, the research Establishment would have to be kept down to 25, including four vacancies. As recruitment had proceeded under Colonial Office and Advisory Council recommendations that the establishment of 35 should be aimed at, the consequence is that certain lines of research of fundamental importance to East Africa, are now represented by a junior worker with no one of experience to guide him, or by a senior worker, who cannot be provided with any staff, while other lines of research are not represented at all. There can be no question that this arrangement makes very inefficient use, both of the buildings provided under the capital grant, and of the recurrent grant for staffing and running expenses. That this situation might arise was foreseen in January 1949 when, owing to rising costs, a revised and increased capital grant was made that provided only for the first phase of the building development, and the attention of the High Commission and the Colonial Office was specifically drawn to the danger ahead. It was perhaps inevitable that, in spite of this action, the possibility of January 1949 would become the disconcerting fact of January 1951; but the consequences are none the less serious for having been foreseen.

Recruitment during the year must be regarded as satisfactory, especially in view of the continued scarcity of first-rate candidates. We have been fortunate in obtaining two men of wide experience to control the forestry and soil classification and survey work, Dr. Griffith and Mr. Gethin-Jones respectively. Dr. Griffith was, formerly, Silviculturist at the Forest Research Institute, Dehra Dun, India; Mr. Gethin-Jones during his service with Kenya, has spent many years studying East African soil types. The other appointments

were:—Mr. Hesse, soil chemistry; Mr. Chamberlain, spectrography; Mr. McKinlay, entomology; and Mr. Jennings, plant breeding and genetics.

Under the head of C.D. and W. schemes attached to E.A.A.F.R.O., Miss Kemp has joined the Termite Research Scheme for work under Mr. Harris, and Mr. Trapnell, who is in charge of the Training Scheme for Ecologists, assumed duty.

It is gratifying to record the award of the O.B.E. to Mr. Greenway, in recognition of his many years of valuable service to systematic botany, as officer in charge of the Herbarium.

Scientific work of the Organisation

Soil Fertility

(Field and laboratory investigations)

Field Experiments.—Unlike last year, this work had a favourable season. This was a gratifying occurrence for the fertiliser team who, under Mr. Doughty, set out no less than eighty-four experiments of which only eight were failures. The experiments covered a wide range of new and old sites, the latter including experiments both for cumulative and residual effects of fertilisers.

Conclusions after only three years' trials must at the best be tentative, and liable to modification, or even withdrawal, when a longer run of results becomes available. With this reservation it can be stated that the need of the lighter soils—sands and sandy loams—is for nitrogenous manures, to which, in seasons of adequate rainfall, they show satisfactory responses. The heavier soils—clay and clay loams—show a more complicated behaviour. There are still no signs of clear-cut and simple generalisations either on the response to phosphate manuring, or on the relative efficiences of the different types of phosphate manures; nor, indeed, could they be expected. Much more work remains to be done, not only by field trials, but also in the spheres of soil classification, and research on the fertility status of the soil types themselves, before valid generalisations emerge. Meanwhile, there is some evidence, of practical significance, that on those soils that do show a response to phosphatic manuring, the best economic response to the manure is obtained from smaller amounts than the basic dressings used in our experiments. (triple super 0.96, "soda-phosphate" 2.08 cwt./acre). The accumulating evidence is also tending to confirm the earlier tentative conclusion that applying phosphates for several years in succession on the same land enables a reserve to be built up, so that marked responses to phosphate are ultimately obtained, in place of the little or no response of the initial years. This is true even of the finely-ground but otherwise untreated Uganda rock-phosphate, with the qualification that this material gives very variable responses, the reasons for which are not yet understood. The cumulative effect of both triple-superphosphate and "soda-phosphate" is more regular; but although triple-super is somewhat better, the "soda-phosphate" has shown its value.

On the practical side of farm management, this cumulative or long-term benefit from phosphate manuring cannot be separated from the question of what point in an arable rotation the phosphate is best applied. The increasing emphasis on the necessity for a temporary grass ley or its equivalent, in East African conditions, carries with it the problems whether the grass break is not the best place for phosphate fertiliser applications; and whether—as in the humid conditions of Western Britain and in the well-known experiments of Hopkins in Illinois—the cheap although slowly available ground-rock-phosphate cannot be exploited for grassland application in place of the more expensive but quicker acting super and soda phosphates. The work of the Kenya fertiliser scheme, whose period of operation has now expired (see p. 7) was moving towards problems of this kind, and it is satisfactory to record that the work will be continued under the augmented "pasture research" programme of the Kenya Department of Agriculture.

Soil Chemistry.—Although a wide network of field experiments is essential in any attempt to provide reliable advice on manuring, they are not, in themselves, enough. Laboratory researches are essential on the fertility status of the soils, particularly on problems of phosphate behaviour, which have occupied much of Dr. Birch's time in the Soil Chemistry Section, and of Mr. Glover in the Plant Physiology Section. Dr. Birch has developed a suggestive new line of study. He has shown that there is an important relation between calcium and phosphorus in the soil system. The percentage saturation of the base-exchange-capacity of the soil appears to be inversely related both to the phosphate fixing capacity of the soil, and to the response of the crop to phosphate manuring. If this clear-cut relation between a soil property and a crop response to manuring can be shown to hold generally—and work on this is in active progress—it is evident that a big step will have been made in our understanding of the manuring of tropical and sub-tropical soils.

Plant Physiology.—Mr. Glover's studies of maize nutrition in sand culture are, in one sense, a bridge between the soil researches just discussed, and the results of the field experiments of the Fertiliser Scheme. Mr. Glover has already shown (Report, 1948, p. 16) the importance of a correct nitrogen/phosphate balance in plant growth and yield. He has now given further attention to the factors controlling the uptake of the nutrient element, at various stages of the plant's growth. Thus, phosphate uptake increases with growth, and during maturing of the grain continues at a high level; but the actual amount taken up is controlled mainly by the concentration of the available phosphorus around the plant roots. The uptake of nitrogen, like phosphorus, increases with growth until grain is set, when the demand rapidly decreases.

One repeatedly confirmed result in the sand-culture maize experiments is that yield is strongly correlated with the total phosphate in the plant tops; and this in turn is controlled by the concentration around the roots. It would appear that excess phosphate, over the minimum needed for the operation of a plant cell, is used for further growth if the balanced quantity of nitrogen

is available; otherwise, it is stored. Hence, it is possible to have under-nourished plants of widely different sizes but with the same percentage of phosphorus in each. Thus a soil having a low concentration of phosphorus but adequate nitrogen will produce a plant whose percentage phosphorus content is the same as that in one that received a better phosphorus supply plus the appropriate level of nitrogen.

Plant Pathology

The various sections of plant pathology, which are under the direction of Dr. Storey, have made steady progress during the year. In the following discussion of selected aspects, the work of the Clove Research Scheme under Dr. Nutman is included for convenience in grouping.

Cassava Diseases.—The programme discussed on pp. 13—15 of the 1949 Report has been continued by Mr. Nichols in 1950, but unfortunately under rather adverse weather conditions for seed production and field trials. Apart from the record of continued and steady progress in obtaining hybrids of good yielding and palatable properties, and resistant to the two virus diseases—mosaic and brown streak—the main points of interest in the 1950 report are the two stated immediately below.

The first is that it seems justifiable to give increased attention to high yielding clones that are tolerant to mosaic; in the past, resistance rather than tolerance has been aimed at. This change of emphasis in the research programme may only be temporary. The reason for it is to have available, as replacements, selected high yielding and tolerant material in case the mosaic resistant clones should break down ultimately. The second is the intention to resume the basic research, interrupted by the war, on the transmission of brown streak, and the relations between the symptoms and the stages in the plant's growth.

Distribution of selected varieties to territorial agricultural departments is now being augmented. Cassava growing extends over such a wide range of climate that it is unlikely that any one selection could serve both coastal and high altitude areas. Thorough tests for both agronomic and disease resistance qualities are necessary, and the organisation for such trials is possessed by the agricultural departments.

Virus Diseases of Groundnuts.—Dr. Storey has given most of his attention to rosette disease, as other viruses appear of minor importance. Although the work was started because of its probable importance in the groundnut scheme of the O.F.C., the disease is known to cause heavy losses in most areas of Africa. The recent changes in the agricultural policy of the O.F.C. do not therefore involve any alteration in our own research programme, the results from which have already reached a most interesting and suggestive stage. Dr. Storey, working in close association with O.F.C. staff has shown that, in the Urambo area of Tanganyika, the virus is carried over the dry season to the next growing season by volunteer plants from missed seeds of the previous harvest. This generalisation

is modified, however, by many factors still imperfectly known; the survival and spread of the virus vary from year to year probably because of weather variations that affect the aphis-vector and its natural enemies.

For these reasons, Dr. Storey's laboratory work has been concentrated mainly on the study of the aphis-transmission process, using the technique described in pp. 15—19 of the 1949 Report, with certain simplifications described in pp. 22-3 of the present Report. The past year's work has also included a test of the degree of protection of groundnuts from rosette infection by one of the "systemic" insecticides that are absorbed into the plant, which is then toxic to insects feeding on it. The experiments showed that virus-carrying aphids, although infecting the systemic-treated plant with rosette disease (a result that was expected) were killed by the systemic. Therefore, although initial infection is not prevented, the secondary spread, due to the travel of the colonies developed at the initial centres, no longer takes place. The practical value of the treatment, apart from considerations of expense, will depend on the relative importance of primary and secondary spreads, and this, in turn, will depend on the variations of the environmental factors, most of which have still to be sorted out and studied.

The genetical aspects of this disease problem have not been forgotten. A collection of *Arachis* species is being built up and tested for immunity or resistance to rosette so that the possibility of producing a hybrid resistant groundnut may be explored.

Forest Pathology.—Dr. Rudd Jones has continued his study of the Canker disease of Cypresses, under the arrangement with the Conservator of Forests, Kenya, who has provided a house, laboratory and various facilities near the River Research Centre, Sagana, Nyeri. Field investigations and surveys have given a reasonably complete picture of the disease, which constitutes a serious threat to plantations of this soft-wood. Infection is facilitated by misty conditions and both field and laboratory experiments on this aspect are in progress; the effect of winds in spreading spores will now be studied. The cankers start to elongate about a month after the long rains have begun. In severe attacks, the cracking and drying out of the cankered tissue in the dry season may produce complete ring-barking and the death of the tree.

The much greater susceptibility of *C. macrocarpa* over *C. lusitanica* is now confirmed over a wide range of sites. The reason for this difference is probably to be found in the morphological or histological sphere, and experiments are in progress. Whatever the reason may be, it has been shown in plantation experiments that if all infected *C. macrocarpa* trees are removed, there is a marked fall in the number of new infections of *C. lusitanica.* There would appear to be strong reasons for abandoning the cultivation of *C. macrocarpa.*

Study of the fungus in culture shows there are two distinct strains, one virulent, fast-growing and producing few spores, the other less virulent, slow-growing, but a copious spore-producer.

For the first 12 months Dr. Rudd Jones' investigations were confined to Kenya. It has now been possible to extend his tours to

Tanganyika, and Uganda will be visited early in 1951; these tours will enable an assessment to be made of the relative priorities of the various forest pathology problems encountered.

Sudden-death of Cloves.—The intractable nature of the experimental material has been stressed in earlier Reports and Dr. Nutman's Report for 1950 gives further evidence of this. In view of the cytological evidence that characters usually associated with disease were also present in apparently healthy trees in Zanzibar, Dr. Sheffield collected material from the Seychelles, where Sudden-death is absent. As this also showed the same features, the characters in questions became useless for diagnosis; other methods are under investigation but, to date, without success.

Transmission experiments, both mechanical and by insects, have not yet proved the virus hypothesis. Transmission by grafting is handicapped by the extreme difficulty of securing union, but in one series where successful top-clefts were obtained, two years ago, the new growth is still healthy, although it has developed from tissues taken from a moribund tree; this could hardly be accounted for without assuming that the hypothetical virus is confined to the roots. Therefore, root grafts and transmission experiments with fungi or insects that attack the roots, have become of great importance. Natural root grafts are infrequent, but of these, in the very few instances where one component of the graft has died, the other has died also.

While the hypothesis of a virus pathogen has still, in spite of the results above, a strong circumstantial validity, Dr. Roberts' investigations have revived interest in possible fungus pathogens and research on this aspect is proceeding.

Mr. Way has made much progress on the bionomics of those insects that might be directly, or indirectly, concerned in a virus transmission. The association between the ant *Oecophylla longinoda* and the scale insect *Saissetia* that it tends, and that is strongly suspected as a possible virus vector, has been discussed in earlier reports. Mr. Way is investigating the degree of protection against predators and parasites enjoyed by the scale insect through its association with the ant. In this work, an important and unexpected relation emerged between the clove and coconut crops of Zanzibar. Damage to coconut female flowers, caused by a Coreid bug, is less in areas that adjoin the clove-tree nests of the ant *O. longinoda* than elsewhere, because the ant is probably a predator of the bug. Therefore, there is a possibility that a mass destruction of the ants' nests—should the scale be proved a vector of the virus—might involve some additional action to protect the coconut crop.

Further surveys of Sudden-death in Pemba, made as a preliminary to the Control Scheme (Report, 1949, p. 40) disclosed so many additional outbreaks that, after examining the extent of the extra work and additional financial compensation for felled trees, the Zanzibar Government felt compelled to abandon the Scheme. Meanwhile, the studies of the distribution of the Pemba outbreaks, which led the Clove Advisory Mission to endorse

the recommendations for a Control Scheme, have been continued, and considerable advances have been made in our understanding of the epidemiology of the disease. Mathematical treatment of the surveys of 1948 and 1950 shows that there must now be at least 2,000 outbreaks, and that new outbreaks are constantly arising at a rate that, if maintained, will lead to the death of half the stand of trees in 15—20 years time.

Other Research Activities

Forestry.—Dr. Griffith's work since his appointment has been mainly exploratory and agreement has now been reached on the major research problems, including pathology and entomology which are catered for by other workers. During the year, however, Dr. Griffith has been able to give help to the territories on a number of silvicultural matters.

Soil Classification and Survey.—Mr. Gethin Jones joined the staff only towards the end of 1950. His intention is to select from the very provisional soil map of East Africa, made some years ago by a group under the late Mr. Milne, certain limited areas in which more detailed investigation is needed, and which, further, are of sufficient economic importance, and small enough, to be handled by the nucleus staff available.

Statistics.—One of the activities suggested for E.A.A.F.R.O. in the initial discussions on the functions of an inter-territorial research organisation was to answer, as far as staff and facilities allow, requests from territorial departments for advice and assistance. Although its present strength is only one statistician and one computer, the Statistical Section has played a prominent part in these services. It is satisfactory to note, from the requests received, that the very wide variety of problems that are susceptible to expert statistical treatment is becoming better understood. Thus, the examinations made for territorial departments ranged from the results of entomological experiments to liquoring reports on coffee. Assistance was also given in the difficult problems of experimental field techniques suitable for sisal and coffee. Details of these and other services to the territories are given in Mr. Robinson's Report (p. 51-3), which also outlines the research work done during the year.

The East African Herbarium.—The move of the herbarium and staff from Amani to the new building in the grounds of the Coryndon Museum, Nairobi, occupied over three months, and skilful arrangements were necessary at each end to reduce to a minimum the disturbance to work. Mr. Greenway's report (pp. 30-5) shows that this was achieved. The big task of welding the Coryndon Museum Herbarium of some 20,000 sheets with the Amani collection has been begun. One immediate consequence of some importance in taxonomic botany has been the identification, in some of the early collections, of material that had been type-named by the Berlin Herbarium, whose collection was destroyed in the war.

C.D. AND W. SCHEMES ATTACHED TO E.A.A.F.R.O.

Termite Research Scheme.—Mr. Harris and later, Miss Kemp, have started work on this scheme. The main work has been to

enlarge the collection of Kenya species and to extend the study of the Tanganyika and Uganda collections. The laboratory work includes biological studies of local species at Amani, by laboratory cultures. Certain soil aspects of these studies are being investigated by Mr. Hesse, who is following, by chemical and physical analyses, apparent differences between the soil in the nests and the adjacent soil.

Ecology Training Scheme.—As Mr. Trapnell joined only late in 1950, it is sufficient for the moment to state that close co-operation has already been arranged between the projected ecological survey work and the soil survey investigations planned by Mr. Gethin Jones, and that the contacts between the ecologists and E.A.A.F.R.O. workers in forestry, plant physiology and soil, will be of mutual benefit.

Climatic data in relation to Agriculture.—Mr. Walter's investigations, reported last year (Report, 1949, p. 41) reached a stage where a longer series of radiation, rain and water vapour records were needed than were available in the East African series. Mr. Walter's return to England provided a good opportunity for him to work on the very large set of data recorded by the Meteorological Office at Kew. This arrangement had the further advantage that the technical problem of Hollerith analysis, to which the data have to be submitted, can be discussed on the spot with the Hollerith representatives. As already explained, the research now in progress forms one part of a major research problem in the E.A.A.F.R.O. programme that is as important in the general problem of water conservation and supply as it is in agriculture proper: this is to measure the excess of rainfall over evaporation and then to demarcate the different areas or zones in steps of successively increasing excess.

Amani (H. H. Storey)

This last year of E.A.A.F.R.O.'s occupation of Amani has been one of gradual reduction in commitments. The Kwamkoro Estate was transferred to the control of the Tanganyika Government from the beginning of the year. The Tanganyika Public Works Department reassumed direct responsibility for maintaining the Amani-Muhesa road, a service that Amani had performed for some twenty years. Buildings have been maintained to a reasonable standard and pass into the charge of another High Commission department from the beginning of 1951.

The accounts section was moved to Muguga in June 1950, when Mr. Walter's transfer left Amani without a Secretary. The essential financial and secretarial work was thereafter performed most satisfactorily by the Engineer, Mr. Greenwood, and for varying periods by Mrs. Robinson, Mrs. Brodie and Miss Nutman (on loan from the Clove Research Scheme). The Amani workshop, which during the year losts its three Asian artizans on transfer to Muguga, has been mainly occupied in making the large number of packing cases required for moving the scientific equipment to the new headquarters. Cutting of mvule, grevillea and other local timbers has continued for the above purpose and for equipping and flooring the new buildings at Muguga.

Shortage of labour reduced the maintenance of the Amani plantations to a low level. Despite this, however, we were able to cope with an increasing demand for plants and seeds; and, in particular, over 2,000 lbs. of tea seed were sold to Tanganyika estates. We were able to assist the municipal authorities of Tanga by training horticultural staff and propagating plants for the new Municipal Park and Sir Wm. Lead Memorial.

Consignments of sugar cane from Barbados and South Africa were received into quarantine. Arrangements have been made for the completion of the quarantine period for this material into 1951; but owing to the departure of staff and the poor state of the old quarantine houses, no further quarantine can be undertaken at Amani.

The Superintendent of Plantations, Mr. J. D. Roberts, has been successful in greatly improving the cattle herd, by better feeding and management and by judicious culling. Average yield from a single daily milking rose from 4.26 lbs. in January to 6.53 lbs. in December 1950.

Library

STAFF

Miss J. Ossent	*Librarian (Research)*
Mrs. Black	*Temporary Assistant (To April,* 1950)

Work on the survey of periodical sets proceeds steadily. Its completion will provide the accurate records necessary for the new Library Catalogue which, it is hoped, will be published in 1951. Errors of omission or commission found on written labels were corrected and, as a result, many sets believed hitherto to be imperfect were found to be complete. In spite of the congested shelves it was possible to accommodate the series in their proper sequence and classes. This arrangement will facilitate placing the books immediately in correct position after moving them to the new library.

The first part of the year was spent on the restoration of the Herbarium library. The whole collection of about 700 volumes and publications on systematic botany was transferred to the new East African Herbarium in Nairobi during August. Due to various circumstances a number of books was damaged during transit; but the experience obtained during this "trial run" has been valuable in suggesting precautions for moving the bulk of the library to its new quarters.

The Annual Report for 1949 was distributed and mailed in July, together with new Amani publications. Our mailing list now numbers 600 names of individuals and institutions. Exchange was resumed with several academic institutions in Asiatic and European countries which had become inactive during the last war.

The usual measure of painting book covers with poison for controlling damage by insect pests was abandoned as unsatisfactory. Instead, the wooden shelves were treated with a strong D.D.T. solution in equal parts of petrol and paraffin. An invasion of wood borers was checked successfully by this method and no borers have been seen since. All bindings damaged by insects in the past have been repaired.

The library staff remained small. Mrs. Black resigned in April and was not replaced. Besides a permanent senior African clerk, a number of young untrained Africans gave temporary service under close supervision by the Librarian.

Bookbinding is carried out by a well-organised unit under an experienced African who has eight bookbinders in his charge. Besides the book repairs, they produced about 500 bindings for new or old books and also approximately 150 pamphlet cases.

New accessions include 110 text-books and 62 periodical series either by purchase, exchange or gift. Close to 1,800 items were received and catalogued during the year. Five issues of the Library Bulletin of Recent Accessions were prepared and distributed to the E.A.A.F.R.O. staff.

Barring unforeseen circumstances, it is expected that the library will be installed in Muguga by June or July, 1951.

East African Agricultural Journal

STAFF

D. W. Duthie	*Editor*
Mrs. D. Smith	*Business Manager*

Up to July, 1950, only editorial responsibility rested with the E.A.A.R.I. Amani, and subsequently with E.A.A.F.R.O. The financial arrangements were as follows:—

Subscriptions were received by the Government Printer and passed through the Kenya Government account to the High Commission. In these conditions it was extremely difficult for the financial position to be assessed at any given time, and it is not surprising, therefore, that rising costs of publication brought the balance to a dangerously low level before the true position was known. In this emergency, E.A.A.F.R.O. took over, as from 1st July, 1950, the business management and accounts from the Government Printer and the High Commission Accountant respectively. Mrs. D. Smith was appointed as Business Manager, her salary being met from E.A.A.F.R.O. and not from Journal funds. The accounts, circulation lists etc., were thoroughly overhauled and by the end of 1950 the circulation had risen appreciably over the previous year; on the average, 1,500 copies of each number are now sold, while the free list remains at about 250.

Arrangements have now been made to raise the annual subscription from Shs. 5/- to Shs. 10/- from Vol. XVII No. 1 July 1951, and, unless costs rise again, it is expected that production and distribution costs will be covered.

SECTIONAL REPORTS

Plant Pathology

STAFF

H. H .Storey	*Deputy Director*
R. F. W. Nichols	*Plant Pathologist*
D. Rudd Jones	*Plant Pathologist*
Mrs. A. K. Ryland	*Scientific Assistant*

The research of the Section has followed the general lines set out in the 1949 Report. All members but one of the staff have been present throughout the year; but administrative duties have occupied the greater part of Dr. Storey's time, particularly during the period March to September, when he acted as Director during Dr. Keen's absence on leave.

Virus Diseases of Cassava—R. F. W. Nichols

I was on leave from mid-March to the middle of August. During my absence all the field work connected with the cassava breeding programme was carried out by the Assistant Superintendent of Plantations, Mr. J. D. Roberts.

The improvement of Cassava by inter-specific hybridisation has been in progress at Amani since 1937. The objectives of this work and the progress towards its realisation have been reported from time to time; it is desirable, however, to restate them. The need for improvement is occasioned by the occurrence in East Africa of two virus diseases, mosaic and brown streak, which take considerable toll of the crop. Among true cassavas (*Manihot utilissima*) resistance to both diseases is limited, and the aim of the work being done is to bring in factors for enhanced resistance from other species of *Manihot,* particularly *Manihot dichotoma* and Ceara rubber (*Manihot glaziovii*), which both show high resistance to one or other disease. But both these species have woody roots and in consequence the first-generation hybrids obtained by crossing them with true cassava possess roots which are partly woody and therefore of no commercial value as a source of starch. Hence work over the years has been an endeavour to restore fully tuberous roots by continued back-crossing of the disease-resistant hybrids to true cassava, in the hope that when this has been done a proportion of the clones so raised will retain disease resistance.

The selection of disease-resistant clones possessing satisfactory agronomic qualities continues to be based on field trials carried out in localities where a high rate of natural infection is known to occur. From a field experimentalist's point of view the year has been

disappointing. Trials started in mid-1949 and harvested in mid-1950 suffered very severely in the early stages from drought, the effects of which were only too obvious throughout the period of growth. In some experiments deaths due to this cause amounted to as much as 25 per cent, which is far too high a figure to allow for proper interpretation of results. Apart from actual death of plants, the shortage of rain had a marked depressing effect on yields, a fact which makes it almost impossible to reach a reliable conclusion concerning the potential cropping qualities of individual clones. Climatic conditions, on the other hand, appear to have suited the spread of disease, since the infection rate was high for both diseases. This fact made it possible to discard a proportion of clones on the basis of early infection of individual plants rather than on the sum total infections at the end of an experiment.

In the past, emphasis in selection has been on disease resistance as opposed to tolerance to disease; but there now seems some justification for testing fully clones that may carry a factor for high yield despite susceptibility to mosaic. Experience gained in dealing with inter-specific hybrids—particularly those of Ceara origin—indicates that the reduction in yield, due to mosaic infection, is less in some of these hybrids than is usually the case in ordinary cassava clones. That is to say, they are tolerant of the disease and yield moderately well in spite of it. For this reason, a policy aimed at producing tolerant clones is justifiable as an interim measure, on the grounds that should resistance ultimately break down in those clones primarily bred and selected for resistance, then a series of clones, susceptible, but high yielding, would immediately be available to replace them.

As implied above, the effect of mosaic is to reduce the yield of roots; in some clones this reduction is very considerable and may amount to 50 per cent or more. Except under certain conditions, reduction in *yield* is not a common feature of brown streak disease; in this case the *quality* of the roots is impaired to a greater or lesser degree, depending on the tolerance of particular clones and climatic conditions. Symptoms vary between what appears to be complete field immunity and an extreme form characterised by the presence of numerous necrotic lesions in the roots; in severe cases leaf and stem symptoms are also present. In between these two extremes there is considerable variation in the amount of necrosis developed in different tissues of a particular clone. Low temperatures augment the effects of the disease to the extent that highly intolerant clones may even be killed once they become infected. It now seems probable that climatic conditions other than temperature can intensify symptom expression. The high yielding Ceara-cassava hybrid, no. 4332/2, mentioned in the 1949 report was, for three consecutive years, only mildly affected by brown streak when grown on the plains in the Tanga district where temperatures are relatively high even in the cool season. In the past year, however, the roots of individual plants were so badly affected that their value as food was nil. During the same period, brown-streak symptom-expression was noticeably severe in other districts visited by me and in which the climatic feature common to all was severe drought. Experimental

evidence is needed to confirm or refute the hypothesis that lack of moisture can intensify symptoms.

Seed Production.—Controlled hand-pollination of selected clones was carried out, as usual, during the first two months of the year. Here, again, the drought had an adverse effect. Plants flowered erratically and sparsely and although some 3,900 flowers were pollinated, only 425 seeds were obtained. This is a very poor result; in a normal year the expectation would be about 2,000 seeds. This crop of seeds will be propagated and the seedlings given a preliminary trial during the coming year.

Field Trials.—The preliminary eliminating trial started in December, 1949, at the Kizugu sub-station, fared better for moisture requirements than trials elsewhere and there were comparatively few deaths. In this trial there were 1,700 clones on test; on termination of the trial, in August-September, 456 clones were retained for further testing in fully replicated trials. Some of these clones show promise of being resistant to both diseases, some to one or other disease, while a third group, resistant to brown streak but susceptible to mosaic, was retained for testing for tolerance to the latter disease.

The current preliminary disease-resistance trial carrying 493 clones was planted at the Kizugu sub-station during December. This trial will be harvested in the latter half of 1951 and it will complete the preliminary testing of the 1947-48 crop of hybrid seedlings.

The fully replicated trials planted in August, 1949, on land again made available by courtesy of the Sisal Growers' Association at their Research Station at Ngomeni, 30 miles from Amani, were terminated in September. As recorded at the beginning of this report, the results were disappointing, due to the effects of drought; a further consequence is that interpretation of the results is more complex than is normally the case. Classification for disease resistance and yield of the 300 clones in these trials has not yet been completed. The majority of clones in these trials were second and third back-crossed hybrids of *Manihot dichotoma.* The more resistant of these clones will need to be tested again before any reliable conclusions can be reached concerning their cropping qualities.

Current replicated trials, consisting of another 300 clones, were planted in October, when sufficient rain fell to ensure good establishment. Included in this collection are back-crosses from the three species originally hybridised and F_1 progenies of another two species, but the majority are second and third Ceara hybrid back-crosses. When these trials are terminated in the middle of 1951, it should be possible to decide which of the original species hybrids are going to give the best results. Present indications are that the Ceara hybrids will prove more satisfactory than any of the others. As predicted in an earlier report, it appears improbable that back-crossing will need to be carried beyond the third generation in order to restore desirable morphological characters in hybrids of Ceara origin.

In my last report reference was made to a comparative yield trial designed to test the yield of the heavy cropping inter-specific Ceara hybrid, no. 4332/2, against a standard cassava variety. This hybrid, when grown from healthy cuttings, has yielded as much as 150 lbs. of fresh root per plant after 20 months growth. Harvested at 6 and 12 months there was no significant difference in yields, which, on account of drought, were very low for both varieties. The experiment will be terminated during the coming year when records will be taken after 18 months and two years.

Distribution of Varieties.—During the latter part of the year under review, distribution of cuttings of 25 selected inter-specific hybrid clones was made to the Departments of Agriculture of Kenya, Uganda, Tanganyika and Zanzibar, for propagation and preliminary trial. The collection consisted mainly of second and third back-crossed Ceara hybrids but it also included some promising "Tree" cassava clones and one *M. dichotoma* hybrid. As climatic conditions vary considerably throughout the cassava-growing areas of East Africa, it is unlikely that any one or two clones would prove universally satisfactory over the whole area; for example, a clone suited to high altitudes would, in all probability, not thrive on the coast, and vice versa. For this reason, departments have been asked to test these clones under as widely divergent conditions as possible. It is hoped that this material will be given a thorough trial, particularly for agronomic qualities as well as for disease resistance, before any wide-spread cultivation of any particular clone or clones is contemplated. In future years the best clones raised and tested in the Amani district will be released annually for further trial by agricultural departments.

Future Programme.—Apart from routine hybridising and field testing of selected clones, which must continue for some years, it is proposed, during the coming year, to resume the fundamental studies, interrupted by the war, on the transmission of brown streak disease. In particular, confirmation is required that the insect vector is indeed a *Bemisia sp.* Furthermore, it is desirable to determine how long after infection takes place and at what stage in the plant's growth disease symptoms appear in the roots, and what influences intensity of symptom expression.

Virus Diseases of Groundnuts—H. H. Storey; A. K. Ryland

Research on these problems has continued generally on the lines set out in the 1949 Report.

Concentration has been mainly on rosette disease, although some work has been done on two other viruses, which appear, however, to be of only minor importance. Rosette disease is a cause of heavy losses of crop in most groundnut-growing areas of Africa. Its incidence varies from year to year; while it may appear late and do comparatively little damage in some years, in others it may infect the plants during early growth and reduce yield to a low level. If means for control could be found, confidence in the crop would be enhanced and average yield over a succession of years would be increased.

It is evident that rosette disease is a factor of considerable concern to the Overseas Food Corporation. Co-operation between E.A.A.F.R.O. and O.F.C. has continued on lines previously explained. The O.F.C. will itself publish the results of its experiments and observations. One of our main joint investigations during the year has been to obtain evidence on the manner in which the virus survives through the dry period between two growing seasons. Storey's observations in South Africa (*Ann. Appl. Biol.* 1928, **15,** 26) had suggested that the survival of self-sown groundnut plants through the dry cold winter of the Transvaal might determine the incidence of rosette during the following summer. Observations at Urambo (the O.F.C. development area in the Western Province of Tanganyika) showed that groundnut plants that germinated from seed left in the soil at harvest could survive through the dry season; many were found to be rosetted and to be carrying colonies of aphids. This was true not only of the O.F.C. areas but also of some areas of African cultivation lying between Urambo and Tabora. Officers of the O.F.C. maintained exact records on such "volunteer" plants during the dry seasons of 1949 and 1950 and will no doubt publish them.

These facts point clearly to one means whereby the virus can be carried over from one growing season to the next. The possibility remains that an alternative perennial host of the virus exists in the natural vegetation; but no evidence of any such host has been found, and in the light of what is now known of the groundnut volunteers, it is not necessary to postulate any alternative host to account for the survival, although it is possible that one may be found.

Much remains however to be learnt concerning the survival and spread of the rosette virus. No explanation can yet be advanced for the relatively low incidence of rosette at Urambo in the 1949-50 season, which followed a dry season through which volunteers were known to have survived. Prolonged observations over several seasons may afford a clue, perhaps in the rainfall distribution or some other feature of the climate, whereby it may be possible to forecast the probability of infection in advance of the growing season, and, conceivably, to take precautions based on this forecast. But as yet nothing of the kind seems to be possible. A further line of investigation that deserves attention is the attempt to find a reason for the almost complete immunity hitherto of the Kongwa area from rosette.

Research that might well throw light on this problem is in the bionomics of the aphis-vector, *Aphis craccivora* (Koch)—study of the effects of the climate and other factors on the development and behaviour of the insect and of its natural enemies. It had been hoped that an American specialist in this subject might work in East Africa for a time under the auspices of the Economic Co-operation Administration; but this has not yet proved possible.

Meanwhile Amani studies on the aphis-transmission process have continued generally along the lines described in our 1949 Report. The new transmission technique—in which aphids are allowed to feed on specially prepared germinating seeds—has been used in a large number of experiments, which have kept the Amani greenhouses full

for most of the year. A number of modifications in treatment of the seeds before and after the aphis-feed have been tested in replicated experiments; none, however, has shown any significant effect upon the efficiency of the method. Of some importance is the evidence that the state to which the plumule has developed is without significant effect. It has been our custom normally to expose the prepared seeds to light for two days, causing the plumule to develop and become green, in the expectation that this green tissue would form a more favourable feeding ground for the aphids. But we have now shown that the seed is as readily infected without this initial greening. The technique is consequently somewhat simplified.

For certain types of experiments, where infection was required in already growing plants, we have used the type of leaf cage ("spring tube") that had proved successful in work in *Cicadulina* (*Ann. Appl., Biol.* 1928, **15,** 1). Aphids confined in these tubes to feed on the under surface of a young leaflet were able to infect the plants with rosette virus.

Many experiments have been performed to determine the special conditions under which this species of aphis can successfully transmit the virus. They have, however, as yet added little new to the tentative conclusions that we reported in our previous Report. We have confirmed that the transmission process is of the "persistent" type—that is, an aphis, having once acquired the virus by feeding on a diseased plant, can continue to transmit virus intermittently to healthy plants upon which it may feed during the next few days. We have also confirmed the point that different strains of aphids have greatiy different abilities to transmit; and one strain, which has been determined by systematists as undoubtedly *Aphis craccivora,* has so far failed in all tests.

Trials have been carried out with one of the new "systemic" insecticides, which are claimed to be absorbed into the plant and to render it toxic to insects that feed on it. It is important to ascertain whether these materials can protect groundnuts from rosette infection. Field evidence indicates that infection of a groundnut crop occurs in two stages; for a start, winged aphids migrate onto the crop and, if carrying the virus, infect plants on which they feed; then the progeny of these or other aphids that develop into colonies on the infected plants may move to other plants in the field and infect them. A systemic insecticide could act in two ways: it might protect the plants from infection by migrants in the first stage; or by preventing the development of colonies it might prevent the secondary type of spread.

Our experiments have been directed to settling the former of these possibilities. Aphids carrying virus were caused to feed on groundnut plants at different times after these plants had been treated with a systemic insecticide by a range of methods and at a range of concentrations. Results have shown that the insecticide does not appreciably protect the plant from rosette infection. For this particular purpose, the systemic insecticide definitely failed.

This result could reasonably have been foreseen; but it was nevertheless important to put it to the test. It should be emphasised that, although a systemic insecticide cannot in all probability protect a groundnut crop from the first stage of infection, it could nevertheless have a marked effect on the second stage. Indeed, our experiments, although not designed to test this point, showed that aphids would not survive on plants that had received the insecticide at suitable dosage and at a suitable date previously. They confirmed, in fact, the claims that have been made for this type of insecticide, and results (not yet published) obtained by officers of the O.F.C. Consequently, there is nothing in our results to suggest that the insecticide suitably applied might not check secondary spread of rosette. The value of this treatment would, however, depend on the relative importance of primary and secondary spread on each individual occasion.

Further work has been done on the two virus diseases of groundnuts that produce only a mild mottle of the leaves and relatively little general stunting of the plant by comparison with the rosette virus. When either of these viruses is inoculated into a groundnut plant together with the rosette virus, the resulting infection shows interesting features that are now under study. According to our present evidence, however, it appears probable that the viruses causing these mottles are not closely related to the rosette virus. On the other hand, evidence is accumulating to suggest that there are several strains of the rosette virus itself, distinguishable by the symptoms produced in groundnut plants.

The Uganda Department of Agriculture repeated in 1950 an experiment in spacing of groundnuts, on similar lines to that briefly described in our previous Report. Again there was plain evidence that rosette incidence was less in the closely-spaced plots than in those widely-spaced. The experiment thus confirmed conclusions concerning the spacing-effect that had previously been reached both in Uganda and in some other countries of Africa. The reason for repeating it was mainly in the hope that the design of the experiment and manner of recording results would assist in explaining the underlying reason for the effect. Furthermore, to this end, certain adjacent uniformly planted plots were closely observed by officers of the Department. Interesting results have been obtained from all these experiments, which will in due course be reported in detail by the Uganda Department; but up to the present we have not arrived at a satisfactory hypothesis to explain how spacing controls rosette infection.

We have ourselves carried out a number of field experiments with groundnuts at the Kizugu Substation, ten miles from Amani. This area has proved a fortunate choice, since hitherto its groundnut plots have remained free from rosette infection entering from outside. The purpose of our experiments has been to study the spread of rosette from infection-sources experimentally introduced. They have thrown light on some details of the spread of the virus. Results will, however, be reported later when current experiments are completed.

The introduction of species of *Arachis* from overseas has continued; but we have still a long way to go before we can be

satisfied with our collection. Thanks to correspondents in Canberra, Kew and Sao Paulo, Brazil, we now have the following:—

Arachis Diogoi var., C.P.I. 8988, ex Canberra.
Arachis Diogoi var., C.P.I. 8987, ex Canberra.
Arachis Diogoi var. *Major,* ex Kew.
Arachis glabrata, ex Kew.
Arachis prostrata, ex Kew.
Arachis prostrata, var. No. 1, ex Sao Paulo.
Arachis prostrata var. No. 2, ex Sao Paulo.

Only the first of these has been tested for susceptibility to the rosette virus; it has been infected by grafting in a leaf from a rosetted groundnut plant, although the effect of the disease appears to be mild.

Our purpose in introducing these non-economic species is, if any prove to carry factors for resistance to rosette, to hybridise them with the groundnut, *Arachis hypogaea,* in the hope of producing a new resistant groundnut type.

In preparation for this programme, we have done some preliminary trials of technique. Crosses made between different varieties of groundnuts proved, through segregation in later generations, to have been successful. A few attempts to pollinate groundnut flowers from *A. Diogoi* failed to give any set. This matter has now been placed in the hands of Mr. Jennings, who joined the Genetical Section at the beginning of December, 1950.

Virus Disease of Maize—H. H. Storey

Pressure of other work has prevented any continuation in 1950 of the research on streak disease of maize, beyond the maintenance of the pure lines of *Cicadulina mbila,* which had been bred in 1949.

With the appointment, however, of Mr. D. L. Jennings, it has been possible to reopen the subject of breeding maize for resistance to streak. It is satisfactory that much of the seed stored since breeding was discontinued in 1940 is proving to be capable of germination. Work has begun on testing of samples for streak resistance and for growing the selected resistant plants through to maturity. This will ensure that we have stocks carrying factors for resistance, if it is decided to include breeding of maize for this character in the programme of the Genetics Section.

Forest Pathology—D. Rudd Jones

Canker Disease of Cypresses caused by Monochaetia unicornis

Field investigations and survey.

The study of the distribution of the disease in E. Africa was extended by a visit to plantations in Tanganyika where the disease was confirmed for two localities; Shume in the Western Usambara Mountains and Tukuyu, near the Nyasaland border. In the former area, evidence was found indicating that the first infections had taken place about 1936, and this is probably three or four years later than the first infections at Machakos, S.E. of Nairobi, where cankers at ground level were found on trees planted in 1929 (the causal fungus

was first identified by Dr. Nattrass on cankers found at Machakos in 1942). Both collections of the fungus from Tanganyika correspond with Kenya collections.

Continued recording of sample plots within diseased plantations has shown that cankers starts to elongate three or four weeks after the commencement of the long rains. Ripe acervuli develop in a further four weeks, although in new infections, and in artificially inoculated trees, ripe acervuli are present after three to five weeks. This year, which has been one of good rainfall, acervuli were produced from April to September in the mist belt areas of Mt. Kenya and the Aberdare Mountains and a few cankers became active during the short rains. Trees killed by the disease only become apparent during the dry season when the cracking and drying-out of cankered tissue results in complete ring-barking.

The "wash-down" of conidia initiating cankers at lower branch crotches has been demonstrated experimentally and has been recorded on numerous occasions in the field. As was previously reported (Report, 1949, p. 20), wounding is not necessary for infection, although it is probable that some cracking of the bark tissues takes place at the branch crotch where the secondary thickening of the branch bark impinges against that of the stem to form the "ruffle." Live pruning of branches resulted in a seven per cent increase in the numbers of infections in two plantations treated a month before the long rains.

Preliminary spore-trapping experiments were carried out under misty conditions during August. Glycerine-coated slides exposed 2-5 cms. below ripe acervuli collected up to 50 conidia per sq. cm. per hour. Distance spread of conidia will be studied under windy conditions this year.

Records of the incidence of mists throughout the plantation areas of Kenya are being compiled with the assistance of local Foresters, and thermohygrograph records have been made in two sites of differing severity of the disease. At Chehe, where the average annual rainfall in two rainy seasons is 68.50″, the average number of hours per day when the relative humidity was between 94 and 96 per cent was 9.57 for two weeks during May, 8.75 in July-August, and 5.33 in September-October. At Hombe, a site where the disease has been less severe and where the average annual rainfall is 48.50″, the figures for the same weeks were 9.50, 5.75 and 0.00.

Resistance and Susceptibility of Cupressus species

The difference in susceptibility between *Cupressus macrocarpa* and *C. lusitanica* (Report, 1949, pp. 20-1) has now been observed over a wide range of sites. In two plantation areas on Mt. Kenya, the number of new infections of *C. lusitanica* has fallen very considerably since the removal of all infected *C. macrocarpa* trees. In a further area on the Aberdare Mountains, where the incidence of infection in *C. macrocarpa* reaches 75 per cent, *C. lusitanica* plantations in no instance show an incidence higher than 5 per cent. At S. Kinangop, in a 1948 strip by strip plantation of the two species, the percentage infection in *C. macrocarpa* rose from 28.4 in March to

64.4 in August and 77.3 in January 1951. The figures for *C. lusitanica* for the same dates were 8.4, 11.4 and 18.6.

The growth of the fungus did not differ appreciably on standard bark and sapwood extract agars of the tree species *C. macrocarpa, C. lusitanica* and *C. torulosa,* and this would indicate that resistance is not dependent on the nutritional requirements of the fungus. The possibility that resistance is correlated with particular morphological or histological characteristics is now being investigated.

A number of the plots for testing for field resistance have been inoculated and the remainder will be infected during the long rains provided that the trees are large enough.

Investigations on *Monochaetia unicornis* in culture

Thirty-nine isolates of the fungus are now in culture. Six of these have been obtained through the courtesy of Dr. Nattrass and represent four localities in Kenya. The remaining thirty-nine collections have been isolated from twenty-two localities in Kenya and Tanganyika. There are two distinct strains of the fungus:— Strain A is a virulent strain, growing rapidly on culture media but producing few conidia in culture and then only after a prolonged period; Strain B is a less virulent strain, slow-growing on culture media but producing many conidia on Potato Dextrose Agar within 12-15 days of subculturing at room temperature (15-25°C). Strain B has only been isolated three times and in every case it was from an area where the disease is not severe.

Germination of conidia was found to be 100 per cent following exposure to a saturated atmosphere at 15-25°C for 20 hours. If the relative humidity was reduced to 97.5 per cent, the germination was only 54 per cent after 20 hours but rose to 89 per cent after 70 hours. At 95.2 per cent R.H. the germination figure reached 66 per cent after 70 hours. No germination was observed at relative humidities of 90 per cent or lower. Mycelial growth was limited at 90 per cent R.H. and there was no growth at 80 per cent R.H. if the agar medium had been exposed to these humidities for seven days prior to inoculation. Growth on 2 per cent agar immediately inoculated and exposed to lower humidities resulted in extensive growth even at 80 per cent R.H. These experiments failed to yield information on the humidity requirements of acervuli production because of the small numbers formed on agar by collections of Strain A. The experiments will, however, be repeated using Strain B and both strains on sterilised Cypress twigs, since the production of acervuli on this medium is good with both strains (Ciccarone, A. 1949 *Ann. Sperimentazione Agraria* 3, 1-57).

Armillaria Root-rot

The recording of sample plots for the spread of the disease has continued. Evidence was obtained, in two plantations, that *C. lusitanica* can recover from the disease. This recovery may be only temporary as examination of trees was necessarily confined to the collars. *Pinus patuka* and *P. radiata,* one and two years old, are

being killed by the fungus in one area planted-up after the clear-felling of canker-infected *C. macrocarpa*. Adjacent *C. lusitanica* plantations show a low incidence of the disease.

Control experiments were carried out in two sites. A series of trenches 2'6" deep, and at varying distances from centres of infection, failed to halt the spread of the fungus, but the complete removal of infected trees, with as much of their root systems as possible, has proved effective with only one further tree infected after eighteen months.

Other tree diseases

Heart-rots, attributable both to infections through roots and through above-ground wounds, have been recorded from Cypress plantations. A number of fungi have been isolated and are being investigated.

At Rau Forest, near Moshi, Tanganyika, young striplings of Mvule (*Chlorophora excelsa*) were found to be infected by *Helicobasidium compactum*. Incidence of the disease and the large numbers of deaths were thought to be associated with a high water table. Trees of the same species in a nearby plantation were being killed by *Fomes noxius*.

A die-back of the leader in *P. radiata* has been reported from several places but has so far only yielded *Pestalotia funerea*, which is probably secondary. A spot necrosis of the needles of the same species is also being studied.

Future programme

Regular tours have been made throughout Kenya and, during October and November, a trip was made through the main forest areas of Tanganyika. Uganda is to be visited in March 1951. As a result of these tours, considerable experience of problems of forest pathology and their relative priorities has been gained, and valuable contacts made with Forest Officers. Numbers of specimens of diseased trees have been sent in for examination.

During 1951, field observations and laboratory work will continue on the Canker Disease and Armillaria root-rot, and a more detailed study of the various heart-rots of Cypresses and diseases of pines will be undertaken.

I should like to acknowledge the considerable assistance which I receive from Dr. R. M. Nattrass, Senior Plant Pathologist, Department of Agriculture, Kenya, and Dr. G. B. Wallace Pathologist, Department of Agriculture Tanganyika.

Publications.

"On the nomenclature and identity of the coliform soft-rot bacteria." *Trans. Brit. mycol. Soc.* vol. 33, 73-81, 1950.

(With W. J. Dowson). "On the bacteria responsible for rot in stored potatoes and the reaction of the tuber to invasion by *Bacterium carotovorum* (Jones) L. and N." *Ann. Appl. Biol.* Vol. 38 (in press).

(With W. J. Dowson). "Bacterial wet rots of potatoes following *Phytophthora infestans*." *Ann. Appl. Biol.* Vol. 38 (in press).

Forestry

Staff

A. L. Griffith — *Silviculturist*

I joined duty in early February 1950, after spending 18 months in the Zanzibar Protectorate appraising forest problems. As a result, Zanzibar now has a Forest Policy, enunciated at a public meeting by H.E. the British Resident, and a Forest Decree which gives legal status to Zanzibar's Forests and Forest Officers.

The immediate necessity in East Africa was to get to know the country and its forest problems, and in consequence the first six months were spent in extensive touring throughout the three territories. This touring showed among other things, how much technical information exists, but how dispersed it is. One of the great needs is for the centralising of this information.

From September to November I was privileged to tour in the U.S.A. as a member of an International Mission for the Study of Tropical Forestry under the auspices of the Technical Assistance Division of the Economic Co-operation Administration. This tour was of the greatest value particularly with regard to softwood nurseries and plantations, hydrology and catchment area management, and erosion and soil conservation. We saw the U.S.A. from Canada to Mexico, and from California to Florida.

We are deeply grateful to the U.S. Forest and Soil Conservation Services for their great help and co-operation in ensuring that we should get the utmost from this unique opportunity.

In December a meeting of a specialist committee on forestry research was held. It was attended by 17 representatives, five from Kenya, three from Tanganyika, four from Uganda and five from E.A.A.F.R.O. This meeting in its three-day session has given us a clear directive for the setting up of a forest information bureau in E.A.A.F.R.O. and has indicated the main problems of forest research in East Africa and their priorities, together with a background of general forest policy. We can now get to work knowing what the territories want and how they want it done.

During the year we have been much handicapped by lack of staff, both clerical and technical, and by lack of a library, but we hope the position will improve in the coming year.

Thus, at last, a forest branch of E.A.A.F.R.O. has come into being with the greatest co-operation of all the territories, and the tours and recommendations of the late Prof. Troup and the Forest Adviser to the Colonial Office (Mr. W. A. Robertson) have started to bear fruit.

Publications.

"Reconnaissance Report on the Forest Problems of the Zanzibar Protectorate," A. L. Griffith, 1949, Zanzibar Government Press.

"Forestry and the Zanzibar Protectorate," A. L. Griffith, 1949, Zanzibar Government Press."

"Working Scheme for the Mangroves of the Zanzibar Protectorate," A. L. Griffith, 1949, Zanzibar Government Press.

"Working Scheme for the Prison Fuel Plantations of Zanzibar," A. L. Griffith, 1949, Zanzibar Government Press.

"The Great Indian Desert," *Proc. Nairobi Sci. and Phil. Soc.* A. L. Griffith, 1950 (in press).

Systematic Botany

STAFF

P. J. Greenway	*Botanist in Charge*
B. Verdcourt	*Assistant Botanist*
Count Staryenski	*Scientific Assistant*

The continuity of work was interrupted by the transfer of the Amani Herbarium to its new building, in the grounds of, and adjacent to, the Coryndon Museum on Ainsworth Hill, Nairobi.

The association of the Herbarium with Amani, which dates from 1902, during the German occupation, thus ceases. But the transfer to a far more central, commodious, specially designed two-storied building with offices, library, work, store and dark rooms, in addition to two large halls for the collections, will facilitate the work both for the staff and for visitors. Further, the amalgamation of the Amani and Coryndon Museum collections will augment the value of the E.A. Herbarium.

Packing, moving and unpacking occupied about 3½ months; and was so organised that interruption to routine work was kept to a minimum. Thanks to careful arrangements made at Amani by Mr. Verdcourt and Mr. Greenwood, Engineer, and to the use of a godown lent by Karimi Tea Estates at Muhesa Railway Station, all the specimens arrived undamaged, and there was only minor damage to other material in spite of the heavy rains during the move from Amani.

The herbarium is not yet, however, in proper working order. We agreed to accommodate, as a matter of urgency, some of the Desert Locust Control staff; the long delay in connecting electricity prevents us from using certain apparatus essential for our work; and finally, because of certain City regulations, no housing is available near the Museum for any of the seven Africans on the herbarium staff; and I have had to house the two seniors at my own quarters.

Owing to the more convenient situation, visitors from East Africa and other regions are increasing, and local members of the

Kenya and Uganda Natural History Society are making full use of the Herbarium.

The Herbarium.—During the year, 141 accessions of botanical material totalling 3,063 specimens were received for identification. Of these, the more important collections were from:—

Uganda:—Agricultural Department (J. W. Purseglove, 539); Forestry Department (H. C. Dawkins and others, 275).

Kenya:—Administration, 9; Agricultural Department, 3; Forest Department, 3; Division of Insect-borne diseases, 3; East African Herbarium (Mr. B. Verdcourt, 53); Veterinary Department, 10; Mr. G. W. Jeffery, 129; Sundry private collectors, 24.

Tanganyika:—Administration (Mr. R. Tanner, 145); Agricultural Department, 21; E.A.A.F.R.O. Amani (Messrs. B. Verdcourt 347, P. J. Greenway, 100; G. Williams, 24 and Miss J. Ossent, 15). Empire Cotton Growing Corporation, Kilosa (Mr. H. J. de S. Disney, 12); Forest Department (Messrs. Carmichael, Gane, Gilchrist, Herring, Hoyle, Kermode, Parry, Semsei and Watkins, 426); Game Department (G. Milton, 82); Government Chemist and Police, 10; Malaria Research Unit (J. Phipps 6); Overseas Food Corporation (Messrs. B. Anderson, 116 and J. D. Lea, 21); Miss B. Tait, 46 and other private collectors, 8.

N. Rhodesia:—8 Cyperaceae from the Botany Department, University of Natal.

Portuguese East Africa: — Agricultural Department, 53 specimens.

In addition to the above, a large collection of Zanzibar and Tanganyika coastal plants collected by Mr. J. H. Vaughan was given to the E.A. Herbarium by Mr. Vaughan to distribute. This collection has still to be dealt with and, judging from the collector's field notes, it contains over 2,000 specimens of which quite a few have still to be named. It is known to contain a number of type specimens.

Nearly 300 named specimens were received from the following:—Royal Botanical Gardens, Kew, (38 Mrs. Faulkner, P.E.A.); Missouri Botanical Garden (248 North Africa); British Museum, Natural History (10 photos of *Pentas* types with descriptions). The Missouri Botanical Garden specimens are of great value as they consist of material collected by A. Pappi in Eritrea and W. Schimper in Abyssinia, both classical collections.

Over 3,500 duplicates were distributed in Europe, South Africa and the U.S.A., the more important being:—The Royal Botanic Gardens, Kew, 988 specimens. National Herbarium, Pretoria, South Africa, 1,203 specimens. Missouri Botanical Garden, St. Louis, U.S.A., 344 specimens.

Loan material for study was received from: The Forest Department, Uganda, 4 *Strophanthus* spp. Coryndon Memorial Museum Herbarium, 17 *Strophanthus* spp. Royal Botanic Gardens, Kew, 75 *Cuscuta* spp. Missouri Botanical Garden, St. Louis, U.S.A. 33 *Cuscuta* spp. Smithsonian Institution, United States National Museum, Washington, 36 *Pentas* spp. Jardin Botanique de l'Etat, Brussels, 6 *Pentas* spp. National Herbarium, Pretoria, South Africa, 4 *Pentas* spp. E.A. Tsetse Research Organisation, Shinyanga, Tanganyika, 20 *Pentas* spp. and related genera, Universitetets Botanische Museum, Copenhagen, Denmark, 1 *Pentas* sp., and Institut de Recherche Scientifique, Tsimbazaba-Tananarive, Madagascar 1 *Pentas* sp.

The *Cuscuta* material was borrowed on behalf of the Royal Botanic Gardens, Kew, for Mr. Verdcourt to prepare an account of the genus for the Flora of East Tropical Africa now in preparation at Kew. The *Pentas* species were also for Mr. Verdcourt, who is monographing the genus together with other related genera.

Some 343 sheets were loaned for study to the following: Royal Botanic Gardens, Kew, 39 sheets Ranunculaceae for the preparation of the Flora of E. Tropical Africa. New York Botanical Gardens, New York, 21 sheets *Strophanthus* spp. Dr. K. Suessenguth, Botanischen Staatssamlung, Munchen, Germany, 190 sheets *Achyranthes, Achyropsis, Alternanthera* and *Amaranthus* of the Amaranthaceae. Naturhistoriska Riksmuseet Botaniska Avdelningen, Stockholm, Sweden, 23 sheets *Struthiola* spp. Botany Department, Natal University, Pietermaritzburg, South Africa, 12 sheets *Fimbristylis* and *Bulbostylis*. Prof. C. E. B. Bremekamp, Botanish Museum, Utrecht, Holland, 11 sheets *Oldenlandia* spp. Senior Pasture Research Officer, Agricultural Department, Kenya, 42 sheets Kenya grasses. British Museum Natural History, 3 sheets ferns, and the Forest Department, Uganda, 2 sheets *Albizzia* and *Fagara*.

Requests for living material continue to be received from all parts of the world, particularly for *Strophanthus*, and over 90 items of living plants and seeds were sent to the Royal Botanic Gardens, Kew (various), to the U.S.A. (*Strophanthus* and *Saintpaulia*) and to South Africa (grasses and legumes), etc.

As a result of Amani closing down, it is now no longer possible to import seeds and plants for trial there and collections of 12 species of *Strophanthus* seeds sent to Amani by Kew are being tried through the kind offices of the Amboni Sisal Estates, at Amboni near Tanga, and the Agricultural Department, Uganda, in the Entebbe Botanic Gardens.

At the request of the Colonial Products Research Council additional bark material of *Mitragyna rubrostipulata* (K. Schum) Havil, has been collected and sent to Professor J. W. Cook, the University, Glasgow, and as a result of several cases of poisoning, tubers of *Dioscorea sansibarensis* Pax have also been forwarded to Professor Cook. Hitherto investigators have been unable to find any toxic properties in this plant. Bark of *Teclea simplicifolia* (Eng.) Verdoorn, was obtained through the kind offices of the Forest

Department, Tanganyika, and send at the request of Colonial Products Research Council to Dr. J. R. Price, Commonwealth Scientific and Industrial Research Organisation, Chemistry Department, University of Melbourne, Australia.

Over 5,500 specimens have been determined in the course of the year and notes and information supplied to technical departments of governments in East Africa, private individuals, commercial firms and institutions at home and abroad. These included the naming of over 1,000 specimens from the Kivu district of the Belgian Congo, over 100 from Northern Rhodesia in connection with ecological surveys; over 1,000 from Tanganyika in connection with the timber resources of the Territory; over 900 from Uganda for forest and agricultural surveys; and about 150 from Portuguese East Africa for land development surveys.

The big task of combining the Coryndon Museum Herbarium (which contains 20,000 sheets according to the Coryndon Museum Botanist's estimate) with that of the Amani Herbarium was started early in November. So far 32 families have been dealt with. This task cannot be done rapidly as specimens in both herbaria have to be compared with one another so that agreement can be reached as far as possible in regard to the specific, and even sometimes the generic, naming of a specimen. This all requires time and has to be undertaken when other and more important work permits. So far it has not been unprofitable because some little known and unrecorded types have been found in the very early collections from the Kenya Forest Department. Apparently, some of these early collections were sent to Berlin for naming, and the discovery of some Berlin types, now that the Berlin Herbarium has been destroyed, is of considerable importance in the realm of taxonomic botany.

In the course of naming collections both at Amani and in Nairobi, a further 31 types were found; the following new species were described from the Amani Herbarium:

Achyranthes aspera forma *monstrosa* Suessenguth (Amaranthaceae) in Kew Bull. 4, 1949, p. 475.
Davies AH. 9684! type.

Achyropsis greenwayi Suessenguth in Kew, Bull. 4, 1949, p. 475.
Greenway 6740! type.

Aerva sansibarica Suessenguth in Kew, Bull. 4, 1949. p. 475.
Greenway 1202! type.

Celosia populifolia Moq. var. *pluriovulata* Suessenguth in Kew Bull. 4, 1949, p. 476.
Glover and Gilliland 833! type 727!

Ochna braunii Sleumer (Ochnaceae) in Fedde Sp. Rep. Nov. 39: 276 (1936).
Braun 1209! type: *Schlieben* 6530.

Othiophora parviflora Verdcourt var. *iringensis* Verdcourt. (Rubiaceae) in Journ. Linn Soc. (Bot.) 53: 408 (1950).
Emson 372! type.

Pandiaka fasciculata Suessenguth (Amaranthaceae) in Kew Bull. 4, 1949 p. 477.
Greenway 7620! type, *Lindeman* 846!

Psilotrichum africanum Oliv. var. *pilosum* Suessenguth in Kew Bull. 4, 1949, p. 478.
Purseglove 1824! type.

Psilotrichum amplum Suessenguth in Kew Bull. 4, 1949, p. 478.
Glover and Gilliland 402! type.

Psilotrichum gloveri Suessenguth in Kew Bull. 4, 1949, p. 479.
Glover and Gilliland 396! type.

Sericocomopsis grisea Suessenguth in Kew Bull, 4, 1949, p. 479.
Haarer 499! type, *Greenway* 7502!

Sericocomopsis pallida (S. Moore) Schinz var. *parviflora* Suessenguth in Kew Bull. 4, 1949, p. 480.
Glover and Gilliland 70! type.

Tricalysia gilchristii Brenan (Rubiaceae) in Kew Bull. 3, 1948 p. 499.
Gilchrist F. D. 1728! type.

These additional records bring the total number of known isotypes in the East African Herbarium up to five hundred and twenty-one.

In the period January to June, 1,666 specimens of which 158 were grasses, were filed in the Herbarium, making a total of 61,223 sheets. Among these there are 7,751 grass specimens for study. During November-December, 1,325 sheets were transferred from the Coryndon Museum Herbarium, making a grand total of 62,548 sheets.

Field Work.—With the duties of Officer in Charge of Amani for practically seven months out of the twelve, and the business of packing up the section, little field work was possible. Brief trips were made in the Amani District, to the coast, north of Tanga, and a few days were spent in the West Usambaras *en route* to Nairobi collecting botanical material.

A discovery of phytogeographical interest was a new species of *Pterygota* (Sterculiaceae) in the vicinity of the Sigi Caves just north of Tanga. This is a genus of trees containing five or six species that has hitherto been recorded from West Africa, with one undescribed species in Uganda, and one only known from the type specimen from Western Tanganyika. Almost at the same time

another has been discovered in the Lake Province of Tanganyika by a member of the Forest Department. This western African genus has now a discontinuous distribution from the west side to the east coast of Tropical Africa.

Other interesting phytogeographical records of trees are *Cordia millenii* Baker (Boraginaceae) a West African species represented in Uganda, has now been found in Kakamega, Kenya. *Oxystigma* (Caesalpiniaceae) a West African genus with four species, one *O. msoo* Harms, only recorded from the Rau Forest, Kilimanjaro, with a doubtful record from the East Usambaras, has now been collected from the Uvinza District, West-Central Tanganyika; another has also been recorded quite recently in the Belgian Congo. *Hyalocalyx* a Madagascan genus of herbs with two species, one of them *H. setifer* Rolfe, has turned up in a collection from Portuguese East Africa, where it is apparently quite common.

Publications.

Notes on the Genus *Bersama* in Africa, B. Verdcourt. Kew Bull. 2, 1950, pp. 233-244.

The Habitat of *Cuscuta europea* in Britain, B. Verdcourt. Watsonia 1, 5, pp. 291-5 (1950).

Plant Physiology

STAFF

J. Glover — *Plant Physiologist*

Miss D. M. Cooper, Scientific Assistant, temporarily on loan from the Section of Soil Chemistry, reverted to that Section when the work on which she was engaged was completed at the end of 1949.

The main work of the Section is to study the nutrition of crop plants with particular reference to fertiliser practice. It is related to the work of the Fertiliser Scheme. So far, because of shortage of staff and equipment, only the nutrition of maize by the major elements, nitrogen, phosphate and potash, has been studied. It will be extended to include other plants and other elements, including the "minor" elements, when facilities permit.

Work on the nutrition of maize in sand culture was resumed when I returned from leave in May. A summary of the main results is given below. One interesting feature is that some of the conclusions derived from the laboratory experiments have shown good agreement with the results of a field experiment with fertilisers.

It has been found that the maize plant requires balanced nutrition by nitrogen and phosphorus throughout vegetative growth if it is to grow efficiently. Within wide limits the level of the potassium supply does not appear to affect growth, though it does modify the water content of the plant. As the plant grows, it takes up increasing amounts of nitrogen and phosphorus until it has

headed and set grain. Thereafter, as the grain matures, the demand for nitrogen falls off rapidly, but the demand for phosphorus continues at a high level. Although this appears to show that nitrogen and phosphate fertilisation might possibly be delayed, with advantage, until the peak demand must be met, a closer examination of the experimental data shows that for phosphate this would probably not be of any real benefit and indeed might be detrimental to high yields. The size, yield, uniformity and earliness of maturity of the maize plant seem to depend to a considerable extent on the concentration of the available phosphorus in the medium surrounding the plant roots. The total amount of phosphorus in the top of a plant at any one stage of growth was found to depend only on the concentration of the nutrient solution. It was not influenced in any way by wide variations of the nitrogen and potash supplies. In fact, no amount of excess nitrogen caused the plant to take up more phosphate than the amount set by the level of *concentration* of the supply, even when the *total amount* of available phosphate was greatly in excess of the plant's needs. This seems to indicate that it would be advantageous to use all reasonable means to obtain and maintain a high concentration of available phosphate in the soil during early growth.

Nitrogen fertilisation seems to be more straightforward. The evidence points to the conclusion that, as long as there is sufficient nitrogen in the soil to maintain balance with the phosphate supply during early growth, nitrogen manuring might be delayed, with advantage, if soluble nitrogen fertiliser is likely to be lost by leaching beyond the root-zone during early rains. On the other hand, too long a delay might lead to nitrogen shortage during the period of peak demand, which occurs just before and at heading.

The chemical analysis of young plants growing in the field has been used extensively in Europe and elsewhere as a means of determining their fertiliser requirements. My experimental results suggest that this might be a useful method for the determination of phosphate deficiencies in East African soils, but instead of the common method of comparing the percentage of phosphorus in the young plants, grown on the soil being investigated, with the percentages expected in well-nourished plants of the same age, it would be better to compare their contents of total phosphate. As already mentioned, the total amount of phosphorus in the plant at any one time was found to be determined only by the level of concentration of the phosphorus supply. Thus the total phosphate content of the plant reflects the concentration of phosphate in the medium surrounding the roots. If it is known how much total phosphate, on the average, can be expected in a well-nourished young plant in the field, under different environmental conditions, then, if a soil is to be tested for adequacy of phosphate supply, plants can be grown to the same age or stage of maturity in that soil. Then, if sampling shows that their total phosphate content is less than would be expected in that environment, the soil is likely to be deficient in phosphate and the plants would show a response to an improvement of the phosphate status of the soil if other nutrients are in adequate supply. The degree of response would depend to a large extent on the degree of deficiency of total phosphate. This, of course, can only be tested by field experiments.

For various reasons it is believed that the above conclusion holds for all grasses, so an attempt was made to forecast the result of phosphate manuring in an experiment with sorghum conducted by the Fertiliser Scheme. Because of lack of data the method used was as follows:—

Various workers have shown that phosphate nutrition is apparently adequate when the percentages of phosphorus in young plants of the grass family lie within certain limits. By using their mean percentage values it is possible to obtain an estimate of the possible total phosphorus content of sorghum plants of the same age. This estimated value for total phosphorus content was then used as the criterion for adequate nutrition in the field experiment. It proved to be surprisingly accurate, for those young plants which had less than the critical amount gave lesser yields at harvest and those which had more showed no increase in yield at harvest over those which were adequately nourished, as shown by their total phosphorus content. Further trials must of course be made before the method can be generally applied. As yet we have no knowledge of possible interactions between other nutrients which might affect the results.

In the field experiment referred to above, it was observed that measurement of the *percentage* of the phosphorus in the plant tops was of no value in forecasting response to phosphate fertiliser. I have consistently found yield to be directly and closely correlated with the *total* phosphate in the tops of plants in my sand-culture experiments. Only once out of many experiments was it correlated with the percentage of phosphate in the tops, and then the correlation was of low statistical significance.

There seems to be a minimal percentage of phosphate required for the operation of a plant cell. Once this is satisfied, excess phosphate is used for further growth if nitrogen is available, or is stored if nitrogen is not available. If the plant is growing efficiently, the excess phosphate does not accumulate to any considerable extent, as reflected by increase in the percentage of phosphorus in the tissues, hence it is possible to obtain under-nourished and well-nourished plants of widely different sizes, yet containing the same percentage of phosphorus. A low concentration of phosphorus in the soil will provide only small amounts of phosphorus for the plant yet if the nitrogen supply is adequate, growth will continue slowly up to the limit set by the phosphorus supply. Experiments show that the percentage of phosphorus in such a plant is little less, if at all, than that in a plant which has had a better supply of phosphorus and a suitable supply of nitrogen to maintain its efficiency of use.

In conjunction with the Statistician, I have developed a simple method of estimating the reliability of monthly and seasonal rainfall, with particular reference to its use in assessing the agricultural potentialities of marginal rainfall areas. Its value seems to lie in being able to measure the probability of occurrence of seasons in which the rainfall is distributed in a manner likely to be of most use to the growing crop.

Clove Research Scheme Zanzibar

STAFF

F. J. Nutman	*Director*	(1)
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F. M. Roberts	*Specialist Officer*	(2)
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J. L. Smith	*Scientific Assistant*	

(1) Seconded from E.A.A.F.R.O.

(2) Seconded from Rothamsted Experiment Station.

As in previous years, the work of the Clove Research Scheme has been largely confined to researches on the cause of the Sudden-death disease. Although a good deal of information has been obtained, some of which tends to confirm the virus hypothesis, the main problem still remains unsolved.

We have been able to make considerable advances in our knowledge of the epidemiology of the disease in Pemba. From our own records, combined with data collected during the surveys made in 1948 and 1950, it has been found possible to assess, with some accuracy, the present situation and the rate at which the disease is developing. It is estimated that there are now over 2,000 outbreaks in the island, of an average size of some 25 dead trees. A remarkable feature is that the percentage frequency distribution of outbreak size gives the same exponential curve for both the 1948, and the 1950 surveys, the smallest outbreaks being the most frequent. As the situation is not static this indicates that new outbreaks are constantly arising; and such information, combined with other data, indicates that the total number of outbreaks is at present increasing by about 14 per cent per annum. The individual outbreak is spreading at an average rate given by the equation

$$y=3.49+0.327x$$

where y is the annual death-rate and x the number of dead trees in the outbreak. Making certain assumptions we have calculated the probable future development of the Pemba epidemic, and it appears that, if the present rate of progress is maintained, half the stand of trees will have died in about 15-20 years time.

Earlier cytological work had shewn that certain characters often associated with a diseased condition were present in both apparently healthy, and diseased cloves in Zanzibar. To determine whether these might be diagnostic of the disease, a visit was paid to the Seychelles where there is no Sudden-death. In spite of different conditions, all cloves shewed these features, which are thus not diagnostic. Attempts have also been made to use methods devised by Lintner for diagnosing, but without success. Bald's staining techniques are now being investigated.

Very extensive series of transmission experiments by mechanical inoculation to clove and to possible indicator plants have been completed. More recent work has shewn, however, that aqueous extracts from the clove contain a large excess of a protein coagulant, and consequently it is in the highest degree improbable that any results will be obtained. Insect transmission experiments, using insects found on the clove, or common in Zanzibar, are in progress. Fifty-three series of experiments have been made with eight insect species in an attempt to transmit to clove, and to twenty-six indicator plants. Five additional insect species await study. No positive results have as yet been obtained.

Transmission by grafting has also given no positive results, although in some cases union has been established for more than two years. One series is worthy of specific mention. In December 1948, a series of scions were taken from a suspect tree which died three weeks later. Four top-clefts were successful, and these have now developed into healthy young plants, all new growth being derived from tissues taken from a moribund tree. It is extremely difficult to reconcile this evidence with a belief in systemic virus infection; but it might be explained were the hypothetical virus confined to the roots, as is the case with Phony peach disease. All our attempts at root-grafting have failed; but three further lines of investigation are in progress.

We are endeavouring to work out techniques to use the semi-parasite, *Cassytha filiformis* and the root mealy-bug *Geococcus sp.* to transmit from root to root. Natural root-grafts are also being studied. Occasionally a volunteer seedling arises close to the trunk of a clove tree, and continues to grow adpressed to it. Sometimes a root union is formed, sometimes not. If the causal agent of Sudden-death is a virus, it would be expected that, if the large tree dies from Sudden-death, the adjacent sapling would die almost simultaneously if grafted; but would survive if not grafted. Death of the sapling is extremely rare, but the few instances so far studied shew a positive association between root-grafting and simultaneous death.

The hypothesis, referred to in the last Annual Report, that a xylem-inhabiting, toxin-producing fungus causes the disease has proved unfounded. A number of fungi have been isolated but no evidence in favour of pathogenicity has been found for any. It has now been decided to re-examine the possibility that a primary root pathogen might be the cause, in spite of Campbell's evidence to the contrary. Early results make it evident that a thorough investigation of this possibility is necessary.

A detailed study is also being made of fungi associated with the dieback disease, which is probably due, primarily, to bad husbandry or unsuitable conditions. Several weak pathogens and one strong one have been isolated and the latter has also been found in roots of Sudden-death trees. This fungus, at present unidentified, when inoculated to seedlings, can cause the symptoms of spectacular Sudden-death in that part of the plant above the place of inoculation.

It seems possible that some deaths ascribed to Sudden-death proper may be due to it.

The entomologist arrived in May, and immediately started a survey of the insects which can feed on the clove tree. Thirty-nine species have so far been found, including one aphid, one Psyllid and four mealybugs: the remainder are coccidae. Some of these are being studied as possible vectors.

An investigation has also been undertaken, of the relations between the ant *Oecophylla longinoda*, the insects which it tends, and the other ants. Except in certain areas near Zanzibar town, *Oecophylla* is widely distributed and has been recorded as tending some 30 different species of insects on about 40 species of plants. *Saissetia* is the most common insect and has been recorded on nineteen different hosts, including coconut, citrus, and mango. Both *Oecophylla* and *Saissetia* benefit from the association particularly the latter which virtually disappears in the absence of the ant. The factors responsible are now being studied in the laboratory and present indications are that insect parasites and predators are largely responsible for destruction of *Saissetia*. *Oecophylla* apparently affords a high degree of protection against predators and partial protection against parasites, but provisional results of experiments not yet completed, in which parasites and predators are artificially excluded, suggest that under such conditions the scale may develop as satisfactorily in the absence of the ant, as in its presence.

In certain areas of Zanzibar, *Oecophylla* has been replaced by the exotic ant *Anaplolepis longipes* and the conditions favouring this are being studied. An interesting and important side-line of this work is being followed up although it has no obvious bearing on clove problems. In the *Anaplolepis* areas, coconuts suffer damage by a Coreid bug and experiments have shewn that a single individual can destroy at least twenty-five young female flowers. Relatively little damage is observed in *Oecophylla* areas, and it seems probable that *Oecophylla* is predatory on the bug whereas *Anaplolepis* is not. Experiments are now being undertaken to make closer investigation of this inter-relationship, and to increase our knowledge of the ecology of both ant species.

Investigations of the variations in soil moisture under clove-trees continued. It would seem that these are almost entirely due to water-uptake by the tree, that of various cover crops being comparatively small.

Grafting to the stocks has, contrary to our expectations, produced a few successful unions, although the percentage of success is very small. Of 733 apparently successful grafts, the following have survived.

Psydium guajava	4
Eugenia polyantha	2
Eugenia jambos	1
Eugenia jambolana	3
Eugenia javanica	11
Syzygium cordatum	21

Only the latter appears to be a possible commercial stock, and since it flourishes under conditions where seasonal water-logging prevents clove cultivation, it may possibly enable clove-growing to be extended. It will be many years, however, before the behaviour of the clove on this stock will be known.

Fertiliser Scheme

Staff

L. R. Doughty	*Officer-in-charge*
D. W. Gourlay	*Field Experimentalist*
T. Graham	*Field Assistant*
W. J. L. A-Worsop	*Field Assistant*
P. H. Hosegood	*Field Assistant*
T. Brodie	*Field Assistant*
T. E. C. Robins	*Field Assistant*
H. F. Birch	*Soil Chemist*
I. W. M. A. Black	*Soil Chemist*
Miss D. M. Cooper	*Scientific Assistant*
Miss E. Smith	*Scientific Assistant*

The 1950 season was a favourable one in all areas. On the coast of Tanganyika, however, the early rains were rather variable and the crops did not get away to a very good start. In all eighty-four experiments were planted and only eight were failures. Forty-two experiments were on new sites, twenty-two repeated for a second time on old sites, eight repeated for a third time, and twelve planted to determine the residual effects of fertilisers.

All these experiments were a factorial type but eighteen of them were simple, 2-factor, experiments distributed over the apparently phosphate deficient areas of Nyanza Province, Kenya, with the object of defining the limits of these areas. The fertilisers used for these simple experiments were sulphate of ammonia and triple superphosphate. African cultivators in North Nyanza were very co-operative in providing sites.

Crops

Finger millet was planted extensively during the season, thirty-five experiments being under this crop in Nyanza and Uganda. Maize was planted on seventeen experiments. In the Lake Province, Tanganyika, sorghum, bulrush millet and cotton were used, and on the coast maize and sorghum.

Harvesting.—The method of harvesting and sampling was the same as last year but it is now obvious from the accumulated data that this procedure is unnecessarily laborious and that it is only necessary to weigh the total produce, heads or cobs, and take duplicate samples from the produce of the whole experiment for an estimate of the percentage reduction from heads to dry grain.

Results

Before proceeding with a description of the results it is convenient to restate the rates of application of fertilisers. A basic dressing of sulphate of ammonia is 0.95 cwt/acre; triple superphosphate 0.96 cwt/acre; sodaphosphate 2.08 cwt/acre; Uganda rock-phosphate 3.64 cwt/acre; muriate of potash 0.48 cwt/acre; Kraal manure or compost 5 tons/acre.

All fertilisers, except the nitrogenous one, were placed in furrows about 3″ deep, covered with soil and the seed sown at a depth of about 2″. Sulphate of ammonia was applied by side placement when the crop was established except for the first dressings in the time of application experiments, when it was applied in the drill with the other fertilisers.

Nyanza Province, Kenya.—A new experiment using finger millet with the phosphatic fertilisers soda and superphosphate applied at half and full basic rates, broadcast and in drills, showed marked response to the half basic dressing and little added response to the second half basic dressing, with no significant difference between broadcast and placed fertilisers. Four other new experiments, two on maize and two on finger millet, using full basic dressings showed responses to nitrogenous fertilisers but not to phosphates, whereas, three experiments—two finger millet and one maize—fertilised for a second time in the same area, showed a marked response to both phosphate and nitrogen.

Of the experiments testing residual effects—all using finger millet—only two showed statistically significant effects of phosphate although all had responded to phosphates in the two previous seasons. On two more experiments—crop, sorghum,—the old treatment plots were split and half-plots treated with either sulphate of ammonia or triple superphosphate, or both together and no treatment. One of these experiments, at the Bukura Training Centre, gave an overall response to nitrogen and a marked response to the new superphosphate on plots that had had no phosphate or rock phosphate in previous years. There was only a small response to the new super on the old soda and superphosphate treatments. The second, at Maseno Seed Farm, showed a marked residual effect of rock, soda and superphosphate, and a response to the new superphosphate on control plots, and in descending order of magnitude, on old rock, soda and superphosphate treatments. It, therefore, appears that on these phosphate deficient soils a build up of phosphates can be made fairly quickly by the use of either local or imported phosphate with marked increases in yield.

The simple type of experiment was used in three areas, Kitosh and Buholo in N. Nyanza and Kisii in S. Nyanza. In Kitosh the expected response of maize to super was not shown, nitrogen being the active element. Buholo experiments, with finger millet, showed marked phosphate responses as did all but one of the experiments in Kisii.

Mbale District, Uganda.—Once more marked responses were obtained in this area to nitrogenous fertiliser applied to finger millet,

only two experiments in the S.E. corner of the area showing any indications of response to phosphate. Two experiments were planted to study the effects of the application of nitrogen at different times during the crop cycle. One experiment showed an overall increase irrespective of the time of application and the other showed a significant difference in favour of the mid-period, i.e., about 50 days after planting.

A single experiment, in Bugishu, with groundnuts, following finger millet, showed no responses to fertilisers. An experiment with sweet potatoes, also in Bugishu, showed a positive nitrogen effect on yield of tops but none of the fertilisers had any effect on the yield of roots.

Lake Province, Tanganyika.—Six of the eight new experiments are on red (Kikungu or Nduha) soils on two blocks of the Tsetse Research Station, Old Shinyanga and were started in an endeavour to find out if the different burning policy in force in the past has had any appreciable effect on the agricultural value of the land. An area has been demarcated on each of these blocks and it is intended to clear and plant a new series of experiments each in addition to a continuation of the old experiments on a rotational basis. None of these experiments showed significant responses to fertilisers in this, the first season, but the yields of the two grain crops, sorghum and bulrush millet, on Block 11, the unburnt block, were nearly double those obtained from experiments on Block 13, burnt annually. With cotton, however, higher yields were obtained on Block 13.

On the red, Kikungu, soil round Shinyanga, there appears to be delayed response to phosphatic fertilisers as these are now showing effect after two or three applications. All experiments show a marked response to farmyard manure; where there is a phosphatic response the proportionate effect of the inorganic fertiliser seems to be much reduced in the presence of either nitrogen or farmyard manure.

On the hill sand soils on Ukerewe Island and the mainland there is a big response by grain crops to farmyard manure, a small response to nitrogen, and no response to phosphate. Two experiments with cotton on this soil type, with old treatments split for treatment with farmyard manure, showed only comparatively small increases in yield of seed cotton and weight of stalks due to the organic manure.

Coast, Tanga and Eastern Province, Tanganyika.—On new experiments in these areas there are no marked responses to fertilisers. Two out of three of the repeat experiments that showed phosphate responses last season, still showed marked responses to soda and superphosphate. In one locality in the W. Usambaras, experiments on heavy, peaty, swamp land have shown a marked, consistent response to muriate of potash dressings. The 1950 experiments, which have not yet been harvested, show that the potash dressing had made all the difference between a crop and no crop at all. In no other experiment is there any indication of a response to this fertiliser.

The remarks about the murram cap and phosphate response in the last Annual Report need some amendment. Further observation has shown a more widespread occurrence of the murram. In certain areas it now appears that the murram has contributed very largely to the formation of the surface soil whereas in other parts the top soil is an overlayer of different origin, in the areas covered by our experiments apparently derived from weathering of intrusive granite. It is in the former that we appear to be getting the most marked response to phosphates in Nyanza Province.

Discussion

Most of the lighter soils, sands and sandy loams, in the regions covered by our experiments appear to have a balanced mineral fertility and, given an adequate rainfall, respond to nitrogenous fertiliser. In the Lake Province, there is a lower response to sulphate of ammonia and a marked response to farmyard manure or compost.

The heavier soils, clays and clay loams, of non-volcanic origin, in the wetter districts and possibly even in drier areas, appear to have a lower estimated phosphate status although in general they are much richer in exchangeable bases, and appear to respond to phosphate treatment. In this respect we may have been somewhat premature in cutting out experiments on 'Mbuga' land in the Lake Province, in favour of a fuller investigation of the red soils.

In most experiments to date where there is a marked response to phosphatic fertiliser the proportionate response to the single basic dressing is very much greater than it is to the second dose, and in the one experiment reported above, where the basic dressings were halved, the proportionate response to the half dressing is much higher than to the basic dressing. This indicates that in most cases the basic dressing is above the economic optimum.

It is difficult to explain, except on a theory of phosphate fixation, why there is no response to phosphate fertiliser on some new experiments where a response is expected on the basis of the chemical data. This does not appear to explain the results from the experiment at Maseno described in an earlier section—the delayed but cumulative effect of phosphate—in view of the marked response to superphosphate on the control plots in 1950. It may well be that on newly broken land or land that has been under grass for 2-3 years there is sufficient readily available phosphate in the decaying organic matter even in phosphate deficient areas, to satisfy the needs of the first crop taken, or on the other hand yields may be controlled by the phosphate-nitrogen balance in the soil. Failures and accidents unfortunately reduce the number of continuously cultivated experiments available for study of these points in our series.

During the close season in Nyanza and the coast districts we have been taking a series of surface soil samples from cultivated areas at comparatively short intervals along the net work of roads in these areas. These together with a more extensive series of

simple exploratory experiments in 1951, will, we hope, help to map the soils from the point of view of fertiliser requirements.

In Mbale district, Uganda, where nitrogen appears to be the most urgent requirement, new experiments are to include types of nitrogenous fertilisers and also more work on time of application.

Acknowledgements

Cordial relations have been maintained with all Departmental officers in the sphere of our operations and we have been able to co-operate, mainly with advice, in the experimental work with fertilisers carried out by Departments, in some cases outside the areas covered by our operations. We have not been able to give much assistance to the Department of Agriculture in Zanzibar but have kept in close touch with their problems and their admirable experimental work with fertilisers.

This report is sufficient evidence of the hard work and loyal support of all the members of the fertiliser team. This effort of the field teams in the face of many aggravating difficulties deserves every appreciation.

Soil Chemistry

Staff

H. F. Birch	*Chemist*
I. A. Black	*Chemist* (retired May 1950)
G. T. Chamberlain	*Spectrographer* (arrived Dec. 1950)
P. R. Hesse	*Chemist* (arrived Feb. 1950)
Miss A. L. Alexander	*Scientific Assistant*
Miss D. M. Cooper	*Scientific Assistant*
Miss E. Smith	*Scientific Assistant*

General—H. F. Birch

Throughout 1950 work has been largely confined to the routine analysis of soil samples from the Fertiliser Experiments Scheme and the Highland Fertiliser Scheme. In addition, soil samples from a manurial trial have been analysed on behalf of the Sisal Experimental Station at Ngomeni. Miscellaneous samples for analysis included fertiliser samples and clove roots, while numerous phosphate determinations on plant material have been done for the Plant Physiologist. An investigation was also made into the toxic principles of *Dolichos pseudopachyrrhizus*.

Mr. P. R. Hesse, who arrived on first appointment on 28th February, supervised the analytical work throughout the year and has recently started research work on the influence of termites on soils in East Africa. Miss Alexander went on home leave on 13th March and returned on 31st July to resume her duties with Miss Cooper on the analysis of soils. Dr. I. A. Black left Amani on 16th May, for home leave pending retirement, after which Miss Smith

undertook all the spectrographic analytical work. Mr. Chamberlain was appointed in April, 1950, and arrived at Amani on 1st December. Prior to this, Mr. Chamberlain spent three months at the Macaulay Institute for Soil Research and two weeks at Rothamsted Experimental Station to study the application of the spectrograph to soil analyses. I undertook the direction of the Soils Department on 17th May.

Chemical Soil Analysis.—The modified methods introduced by Dr. Black (Report, 1949, p. 29) have proved satisfactory and all the soil samples so far received from the Fertiliser Schemes and elsewhere have been analysed. The total number of analyses completed during 1950 was 3,675, made up as follows: pH's 565, nitrogens 920, carbons 282, mechanical analyses 238, phosphates (including acid-soluble, adsorbed and water-soluble forms, and phosphate potentials) 1,610, and clay analyses (for silica and sesquioxides) 60. Numerous duplicate determinations of several kinds have also been carried out, and calcium carbonate analyses (20) when these were necessary.

Spectrographic Soil Analysis.—The application of the spectrograph to the determination of exchangeable bases has already been summarised by Dr. Black (Report, 1949, p. 30). The various improvements and modifications that Dr. Black, with Miss Smith, has since developed, both in the use of the spectrograph and in the spectrographic methods, have now been published (see Publications). During 1950, 448 soils have been analysed for exchangeable calcium, magnesium, manganese, potassium and sodium, in addition to 198 complete duplicate determinations and 448 exchangeable hydrogen determinations.

Mr. Chamberlain is now studying the use of the spectrograph in the analysis of bases in plant material. An important application of this work could be to pasture analysis. He is also engaged on further modifying existing and spectrographic methods with a view to further simplifying and speeding up the work. When the Hilger large Littrow Spectrograph is available, Mr. Chamberlain will extend his work to include the determination of trace elements, deficiencies of which are likely to be a limiting factor for crop growth in some East African soils.

Fertiliser Analyses and Miscellaneous Work.—During the year, five phosphate fertilisers from the Highland Fertiliser Scheme have been analysed for total, citric-soluble and water-soluble phosphate, water-soluble alkalinity and fluorine. Seven clove root samples from the Clove Research Scheme, Zanzibar, have been analysed for carbohydrates and one fertiliser sample, from the Kenya Department of Agriculture, spectrographically for bases. Some work on the solubility of D.D.T. in vegetable oils was also carried out for the Coffee Research Station at Lyamungu.

Phosphate Investigations—H. F. Birch

The object of this work was to determine whether chemical tests can satisfactorily be used to forecast the phosphate requirements

of the more important agricultural soils in East Africa. This involved the analysis of soil samples from experimental plots of known phosphate response. Yield data from fertiliser experiments in the Eastern Province, Uganda, North and South Nyanza, the Southern Province of Lake Victoria, and the Eldoret and Njoro areas of the Kenya Highlands, have now been collected and, in conjunction with the corresponding soil analyses, certain conclusions have been reached regarding the usefulness of chemical tests.

Attention was at first confined mainly to the adsorbed phosphate fraction, since it was found that this form predominates in the acid soils on which most of the fertiliser experiments were laid down. It was soon apparent that adsorbed phosphate measurements alone could not give the requisite information regarding the phosphate-supplying power of the soil. On the assumption that the plant mainly depends for its phosphate supply on the concentration of water-soluble phosphate and the ability of the soil to maintain this at a certain level, the relationship between adsorbed and water-soluble forms of phosphate was studied. It was found that the amount of water-soluble phosphate is more a function of the degree to which the adsorbed phosphate in the soil saturates the phosphate-fixing capacity, than of the amount of adsorbed phosphate present. Reasonably good correlations between adsorbed phosphate alone and crop response cannot therefore be expected if he soils under consideration have markedly different phosphate-fixing capacities.

A further relationship was later found between the phosphate-fixing capacity and exchangeable bases. With one series of field experiments, crop response to phosphate was found to be significantly and inversely related to the percentage saturation of the base-exchange capacity which, in turn, proved to be inversely related to the phosphate-fixing capacity. This led to the conclusion that there is an important calcium/phosphorus interrelationship in the soil system, which governs, through the effect of the base saturation on the phosphate-fixing capacity, the availability of the soil phosphate.

In relating chemical tests and phosphate responses, emphasis was therefore placed on the percentage saturation of the phosphate-fixing capacity with adsorbed phosphate and the percentage saturation of the base-exchange capacity. Phosphate responses, however, depend not only on the need of the soil for phosphate (as assessed by adsorbed phosphate and phosphate fixation, or related measurements) but also on the effect of the soil on the efficiency of added phosphate. This depends to some extent on the phosphate-fixing capacity and on the type of reaction that takes place between the soil and the added phosphate. An attempt has therefore been made to assess, from fixation data and simple soil-phosphate equilibrium studies in the laboratory, the degree to which each soil impairs the efficient use of added phosphate.

This approach to the problem of relating chemical tests and phosphate responses appears to be quite successful. With one series of 25 experiments on wheat, the regression of crop response to phosphates on adsorbed phosphate alone was not significant, while response on adsorbed phosphate (as a percentage of the phosphate-

fixing capacity) was significant on a probability between 0.02 and 0.01. In another series of 11 experiments on maize, both the above mentioned regressions were significant on a probability of 0.05 With these maize experiments the phosphate-fixing capacities of the soils did not differ from each other to any marked extent (in contrast to the soils in the wheat experiments) so that a correlation between crop response and adsorbed phosphate was not unexpected. When the fixing capacities are reasonably similar, their percentage saturation, and consequently the amount of water-soluble phosphate, is almost wholly a function of the adsorbed phosphate content. In a third series of 17 experiments on millet, the regression of response (a) on adsorbed phosphate was not significant, (b) on adsorbed phosphate (as a percentage of the phosphate-fixing capacity) was significant on a probability between 0.1 and 0.05 and (c) on the percentage saturation of the base-exchange capacity was significant on a probability of less than 0.01.

With these experiments, the lower the percentage saturation of the phosphate-fixing capacity (with adsorbed phosphate), or the lower the percentage saturation (with bases) of the base exchange capacity, the greater the response. In each of the three series of experiments there were one or two discrepancies where the response obtained fell short of that expected, considering the low percentage saturation of the phosphate-fixing capacity of the corresponding soils. In these instances it was found that the phosphate efficiency factor was operative, and that the expected responses were not obtained mainly because the phosphate-fixing capacity was so high that normal applications of phosphate had not appreciably increased the percentage saturation of the fixing capacity and consequently the concentration of water-soluble phosphate. Equilibrium studies also showed that in one or two instances the added phosphate had been rendered ineffective by chemical precipitation, probably with iron and aluminium compounds.

Some data from the 1950 wheat and grass experiments have recently become available. In each case a very significant ($P < 0.01$) and inverse relationship was found between phosphate response and the percentage saturation of the base-exchange capacity (B.E.C.). The regressions were much more significant than those for response on adsorbed phosphate (not significant), water-soluble phosphate (not significant) and on the percentage saturation of the phosphate-fixing capacity with adsorbed phosphate ($P=0.1$). Further, it was found that the percentage saturation of the B.E.C., through its effect on phosphate availability, was directly related to the magnitude of the control yields.

The theory underlying the relationship between phosphate response and the percentage saturation of the B.E.C. will be published later. Briefly, it appears that available phosphate is that associated with exchangeable calcium through an unstable soil micelle—calcium—phosphate linkage, and that the percentage saturation of the B.E.C. determines whether soil phosphate will be retained largely in the available form or in the less available forms associated with the clay complex through anion exchange or chemosorption. In contrast to the more conventional methods, which determine the

amount of acid-soluble or adsorbed forms of phosphate but take no account of the number of such forms of varying availability that may be extracted, the determination of the percentage saturation of the B.E.C. estimates the probability of the soil phosphate being available and appears to be a promising method for assessing the availability of soil phosphate and crop responses to applied phosphate.

Phosphate Potentials

The phosphate potentials (Report, 1949, p. 32) of all the soils received from the fertiliser experiments have been determined. The potentials are very closely related to the water-soluble phosphate and, as a means for forecasting crop responses, appear to be subject to the same limitations, in that such measurements give no information on the effect of the soil on the efficiency of added phosphates. An evaluation of the phosphate potential method, as a means for advising on phosphate manuring, will be possible when yield data for the 1950 experiments are available.

Manurial Trial—Sisal Experimental Station, Ngomeni

These soils (67) were from the 1936 N and P manurial trial sites at Ngomeni and were analysed at the request of the Sisal Experimental Station. The main effects of the manurial treatments on the soils may be summarised as follows:

(a) N treatments significantly lowered the amount of available phosphate, possibly as a result of increasing plant growth and nutrient uptake.

(b) Indications of exchangeable potash depletion in the N alone treated plots, possibly for the same reason and/or through increased leaching of potassium from the more acid N fertilised soils.

(c) Significantly less exchangeable calcium in the N plots than in the P plots. Phosphate may have immobilised some of the calcium, whereas N treatments favoured increased uptake by the plant.

(d) Significantly less N in the N plots than in the P, NP and KP fertilised plots. One possible interpretation of this unexpected behaviour is that N alone, through increased plant growth, has resulted in the plants using not only additional nitrogen but additional soil nitrogen compared with the plants on the control plots. The addition of P, both with and without N, restores the N status to levels equal to or greater than the control, possibly through increased microbiological activity.

(e) Treatments causing significant differences in pH were NP and NK treatments compared with P, PK and PCa treatments. The significantly lower pH's in the NP and NK plots are to be expected, since N was applied as sulphate of ammonia, a physiologically acid fertiliser.

(f) In both the phosphate and calcium plots there was significantly less exchangeable manganese than in the N treated plots. Since the soils are acid (pH 4.8—5.1) their effects on exchangeable manganese are probably unimportant.

The Toxic Principles of *Dolichos pseudopachyrrhizus*—P. R. Hesse

This is a tuberous root used by the natives as a fish poison and as a substitute for soap. The Entomological Department at Mombasa were considering its use as a molluscicide to control bilharzia and wished to know whether or not it contained rotenone. Preliminary investigations showed the presence of a substance which gave some of the colorimetric tests for rotenone but which could not be isolated. Large scale extraction of the root showed that it contained a considerable quantity of saponin, 13.4 % by weight of the dried root. A yellow resin, comprising 0.02 % of the dried root, was also isolated, which gave the colorimetric tests for rotenone but no crystalline material could be isolated from it. In addition, a pale yellow crystalline compound was obtained (from the root) whose physical constants (including molecular weight) and chemical properties do not correspond to those of any known compound.

Redox Potentials—P. R. Hesse

This work was begun last year by Dr. Birch and mentioned in the Annual Report for 1949. He investigated the variations in redox potentials of muds under different conditions and suggested a method by which the reducing power of any particular mud can be assessed.

The work has been taken a step further by making measurements in the field, both at the Amani lakeside and a swampy area nearby. For this work, modifications of the apparatus were necessary, the most useful being the adoption of a long flexible agar bridge. This was made from "tenoplast" tubing with glass ends. Not only was it invaluable in the field for reaching down into trenches but the agar jelly face could easily be renewed by pushing the glass end further into the "tenoplast." This squeezed out the jelly and obviated having to cut off pieces of glass, as in the usual practice. The length of the bridge did not affect the readings. The redox potentials (Eh) of the wet soils were measured at various depths, the samples then removed and tested immediately for oxidising properties with diphenylamine, with ammonium thiocyanate for the ferric/ferrous ratio, and for sulphide and nitrite. The pH was also determined.

The Eh of the muds was found to decrease with increasing depth. At both sites there was a complete absence of oxidising properties, even in the surface inch, with abundant ferrous iron but no ferric. This, taken in conjunction with the fact that the highest Eh (i.e. at the surface) was 363 m.v., agreed with Birch's conclusions from titration of muds with ferric chloride that below Eh 640 m.v. the iron is almost entirely in the ferrous form.

FLUORINE ANALYSIS—P. R. Hesse

The determination of fluorine in phosphate fertilisers is a tedious and unsatisfactory procedure. This has now been replaced by a more efficient method, based on a combination of existing methods, which takes less than a tenth of the time. The method depends on the formation of a lead chlorofluoride complex which can be determined volumetrically or gravimetrically.

Publications.

"The Routine Determination of Exchangeable Bases in Soils by the Lundegardh Flame Spectrographic Method," I. A. Black and E. Smith, J. Sci. Food and Agric., 1, 201.

Statistics

STAFF

P. Robinson — *Statistician*

The work of the section continued along the lines started during 1949. The design and analysis of fertiliser experiments again constituted a major part of the work; most of these experiments were carried out by the Kenya and E.A.A.F.R.O. Fertiliser Schemes, but there were several for the Department of Agriculture of Tanganyika, among which were the results of the wheat experiments in the Iringa District mentioned in last year's report. The results of these were very disappointing for it was hoped that some combination of artificial fertilisers could be used to boost the dwindling yield of wheat in that area, but only organic manure—supplies of which are very limited—proved to be beneficial over the greater part of the district. The report on the experiments conducted by the Fertiliser Scheme will be found in the appropriate section of this annual report, and the results of the Kenya Fertiliser Scheme experiments are at the moment being collected in the form of a report on the three years' work.

The soils from sites on which the two Fertiliser Schemes carried out experiments were analysed by the chemistry section; correlation of these results with the results in the field is a problem of major importance. The practical use to which soil analyses have so far been put is very limited because, except in extreme cases, there has appeared to be little correlation between the yields obtained in the field and the chemical analyses obtained in the laboratory. They have given little indication, even to the most experienced worker, of what application of fertiliser is required. Several workers have made use of the Mitscherlich yield curve to determine the quantity of fertiliser required, and the theoretical calculations generally seem to have some support in practice. But with high dressings there is a tendency to a fall in the yield, which the Mitscherlich curve does not allow for. It was therefore decided to test the general applicability of a curve of the form

$$y = A\ 10^{ax}\ x^{b}$$

where y is the yield obtained from a concentration of x units of the nutrient in the soil. Provided a is negative the curve is of the

desired form. In the central part of the range the curve approximates to that of Mitscherlich but with high dressings the yield falls, and at very low dressings a point of inflexion may be obtained. This point of inflexion has been noticed by several workers when concentration of certain nutrients are low.

The results of investigations are not conclusive, but appear to be promising.

In addition to the manurial experiments, work was also received from certain of the research stations of the various Departments of Agriculture. Variety trials conducted by the Plant Breeding Station at Njoro were examined and results of experiments of the Senior Entomologist at the Scott Laboratories were analysed.

A visit was arranged to the High Level Sisal Research Station at Thika during the early part of the year, which gave first-hand information on the practical problems and difficulties encountered in the experimental technique applied to sisal. Experiments were discussed and the relevant data was later forwarded to Amani for analysis.

It was also possible to visit the Coffee Research Station at Lyamungu for two weeks, during which time certain outstanding points of difficulty were discussed and cleared up. An examination of data from the sampling of cherry to estimate clean coffee yields indicated that, instead of sampling each picking, a sampling fraction of $\frac{1}{3}$ was sufficient for most practical purposes. Liquoring reports were examined to see whether the uniformly high-grade coffee from the station could be classified into better defined groups for experimental analysis. Results of the long-term manurial and cultural experiments were also analysed.

Grassland development and pasture research are becoming extremely important problems; the Kenya Fertiliser Scheme has already carried out some experiments on established grassland and on sown grass and lucerne. These experiments are to be continued and extended by the Kenya Department of Agriculture and experiments have been designed for this purpose.

Another important problem in East Africa where water is almost everywhere a limiting factor in the growth and cultivation of crops, is the forecasting of seasonal rainfall. The ability to predict, over reasonably long periods, the number of seasons in which a crop could be successfully grown would be a great asset and of invaluable help in deciding whether to open up new areas for agricultural production. In conjunction with the Plant Physiologist this problem was examined and simple statistical methods were used to determine the agricultural potentialities of several districts.

In addition to the agricultural problems and experiments discussed above, it has been possible to examine data from ecological surveys of forests in Uganda. In this, densities of various economically important trees are determined within limits of a given probability. Assistance in the analysis of experiments was also given to a private firm dealing with agricultural products; provided problems of only mutual interest are concerned, co-operation of this Organisation in the design and analysis of their experiments.

As usual, assistance has been given to various Sections of the Organisation in the design and analysis of their experiments.

Joint Division of Animal Husbandry

STAFF

H. P. Ledger — *Farm Manager.*

The Farm Manager, appointed at the end of 1949, on transfer from Uganda, arrived in Nairobi to take up his appointment in January 1950 and was absent from May to December on vacation leave.

The first two months of the year were spent in making a farm survey of an area of some 500 acres, situated in the south-west corner of the station, which had been earmarked as the experimental farm for the joint Animal Husbandry Division of E.A.A.F.R.O. and E.A.V.R.O.

Most of this area had previously been under wattle, which had been cleared and stumped in 1949. Owing to the rapid growth of a dense cover of wattle seedlings, it was found necessary to slash them in order to avoid being faced with further stumping operations later.

To facilitate orderly development and to ensure that a complete history of the treatment of any particular area should be available from the start, the farm was divided into a series of 20-acre blocks, the blocks being two hundred and ten yards in width and so arranged that their length lay along the contour, permanent, numbered posts being placed at 70-yard intervals along the perimeter of each block to provide a standing grid over the whole farm.

Apart from the clearing and ploughing on one small trial plot, which was subsequently sown with *Bromus marginatus,* it was decided that, as no one was available to take over when the Farm Manager went on vacation leave in May, there should be no actual breaking of land until his return. All necessary farm equipment and fencing material was put on order so that there should be no delay in getting ahead with perimeter fencing, paddock fencing and establishment of grazing paddocks early in 1951.

ATTACHED C.D. AND W. SCHEMES

Termite Research

STAFF

W. V. Harris	*Officer-in-Charge*
Miss P. B. Kemp	*Research Officer*

A scheme for termite research under the direction of the Committee for Colonial Agriculture, Animal Health and Forestry Research took effect from the appointment of the writer in September, 1949. Plans for an East African Unit were prepared and the writer transferred to Nairobi in January, where he remained until his departure on leave in December. Miss P. B. Kemp B.A., arrived in September on appointment as a Scientific Officer and has been stationed at Amani. There is a vacancy for a second Scientific Officer.

The immediate objective of the Unit is to study the systematics and geographical distribution of the termites of East Africa as a whole, together with the biology of certain selected species. Collecting during 1950 has been mainly in Kenya, as a result of which the number of species known from this Colony has increased from 19 to 56. The Tanganyika list stands at 60. Collecting trips have embraced most of Kenya from Lake Victoria to the sea, excluding the semi-desert Northern Frontier Division for which suitable transport was not available. A visit was paid to the Kilimanjaro-Meru area of Northern Tanganyika to obtain topotypes of a number of Sjostedt's species. Short visits were also paid to the Overseas Food Corporation farms in Western and Southern Tanganyika. Collections require to be made in Zanzibar, Pemba and the Kenya N.F.D. to complete the survey. A number of new species await description. Several genera new to East Africa are listed in short paper entitled "Further Records of East African Termites" and a description given of *Pericapritermes gloveri*, a new species of a hitherto West African genus. The numerous records now available of many of the more conspicuous species permit of tentative conclusions being drawn about their geographical distribution. The pattern of the East African termite fauna becomes clearer when it is possible to distinguish elements from Congo rain-forest, Sudan savannah and Somalia semi-desert communities superimposed on a general Ethiopian background. As a result, collecting in new areas becomes more systematic as the various habitats or ecological niches are recognised and their occupants sought out. Further work has been possible on the writer's collection of Tanganyika and Uganda termites, special attention being paid to the sub-family Macrotermitinae, in particular to the biometrics of *Odontotermes badius* as a basis for the study of variation both within the individual colony and throughout the geographical range of species.

At Amani, Miss Kemp is studying the biology of the local species by establishing laboratory cultures, and by field work in the various ecological zones. The primitive wood-boring Kalotermitidae are as yet the more amenable to culturing, but methods are being sought whereby the higher termites may be reared in the laboratory. A technique for field surveys based on trenching and on the use of timber traps is being developed.

A number of identifications have been made for other workers. Reference material has been supplied to several institutions. Living colonies of termites have been sent to the Institute Tropical Suisse.

We are indebted to Dr. Albert Emerson of Chicago for valuable assistance. The co-operation of members of E.A.A.F.R.O. is highly appreciated.

Publications.

Harris W. V. "Dry Wood Termites." E.A. Agr. J., **16**, 50.

Kemp P. B. "The Susceptibility of Wood to Termite Attack." E.A. Agr. J., **16**, 122.

Harris W. V. "Further Records of East African Termites." Proc. Ent. Soc. Lond. (B) in the press.

Ecological Training Scheme

STAFF

C. G. Trapnell — *Officer-in-Charge*

Mr. C. G. Trapnell arrived at Muguga on 29th November, 1950, to take up duties as officer-in-charge of Ecological Training. The primary object of the scheme is the training of a number of suitably qualified men for ecological and land use survey work in the Colonies, including the East African Territories. Students will, in the first instance, be young graduates from the Universities, although there should also be room later for the participation of specialist officers of the Colonial Agricultural and Forestry Services. The training work will take the form of carrying out a series of field surveys in East Africa, having regard to areas of potential economic importance (including the zone of the projected East Africa-Rhodesia rail link). Stress will be laid on primary vegetation and soil reconnaissance, on air photo interpretation and mapping work and on investigation of present and potential land usage. Close co-operation in these surveys is intended with the Soil Survey Section of E.A.A.F.R.O. and with the Territorial Agriculture and Forestry Departments.

Apart from its training object, the scheme should be of direct value to East Africa in the production of ecological maps and provision of information on land resources, and in the delineation of zones for field experimental work. Owing to the necessity for an initial period of training in the United Kingdom, no students are at present expected to arrive before the beginning of 1952. During 1951 Mr. Trapnell will carry out a preliminary general reconnaissance of vegetation types in East Africa, during which he will select areas for survey work and make the necessary contacts with the Departments concerned.

Mollusca of N. E. Tanganyika

Bernard Verdcourt.

A preliminary ecological survey of the Mollusca of N.E. Tanganyika was made during 1950 outside official hours and an attempt made to correlate the snail fauna with the vegetational regions.

Little work has been done in this area since Alfred Craven (1880) and Leopold Conradt (1891) visited the Usambaras. Still less is known concerning the anatomy of the molluscs of the region and I have whenever possible collected material preserved in spirit after killing outstretched. This material together with detailed field notes is now in the hands of Mr. H. Watson of Cambridge, and Dr. Venmans of Moergestal, Netherlands. Further dry material has also been distributed to Dr. Bequaert, Museum of Comparative Zoology, Harvard, U.S.A.; the British Museum (Natural History), London; Dr. Pfeiffer, Rammelsberg, Germany; the Coryndon Memorial Museum, Nairobi; and Dr. Venmans. Many new species are represented in the material but the working out will not be completed for several years.

Some of the species collected are of zoogeographic interest since they belong to genera previously unrecorded from Tanganyika e.g. *Punctum* sp. from the W. Usambaras and *Trachycystis* (section *Psychion*) sp. from the E. Usambaras. Although the collection has not as yet been critically named it is possible to summarise the ecology of the mellusca. Four zones can be recognised as one travels up from the coast.

(1) The Mangrove swamps characterised by a very small number of species but a very large number of individuals (chiefly *Potamides decollatus* Brug.)

(2) The lowland zone 0-2,500 ft. formerly covered with a drier type of evergreen forest. *Helicidae* are completely absent but Pomatiasidae are abundant. The general Ledoulzia, *Achatina* and *Tayloria* are abundant. *Urocyclidae* (slugs) are not common. Fresh water species are commoner than in the higher zones.

(3) The intermediate zone 2,500-4,000 ft. corresponds to a much better evergreen forest. *Streptaxidae* are more abundant than in any of the other zones. *Helicidae* are recorded but I have not discovered any. *Pomatiasidae* appear to be entirely absent save for the sparing occurrence of one species of *Tropidophora* on the grasslands on the western edge of the E. Usambaras. *Urocyclid* slugs are particularly abundant, some eleven species having been discovered, a fact clearly related to the humid climate of the region.

(4) The uplands zone 4,000-7,000 ft. corresponding to a dry upland evergreen forest. *Helicidae* are abundant in the Juniper forests on the higher slopes, as also are *Pomatiasidae*. *Achatina* is definitely rare or absent, and *Urocyclidae* are scarce. Certain

rather temperate genera such as *Punctum*, and *Pisidium* occur. *Streptaxidae* are scarcer than in the other regions.

The rapacious snail *Edentulina affinis* Bgttr. which is being used to combat the *Achatina* menace in other countries is fairly plentiful on forest edges at Amani.

During the year materia has been named for the Insect-Borne Diseases Section of the Kenya Medical Department. I am prepared to attempt the naming of mollusca should such service be desired.

One new species from Africa has been described ("A new species of *Hydrobiidae* from the Belgian Congo" 1950, Rev. Zool. Bot. Afric. 43, 213-15). Besides the collection of snails, several hundred insects were collected and these have been given to the Coryndon Museum, Nairobi, and the British Museum (Natural History). Special collections of *Meligethes* beetles, a very neglected group of minute species have been made at the request of the authority of the genus, Dr. A. M. Easton. These collections contain several new species. A new species of ant and one new species of *Staphylinid* beetle have also been collected and are shortly to be described by the authorities in Britain.